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1. ------IND- 2019 0298 CZ- EN- ------ 20190703 --- --- PROJET

Executive summary for the EC (not part of this legislation)

'Current measuring transformers' may be placed on the market and put into use in the Czech Republic as specified measuring instruments in accordance with Act No 505/1990 on metrology, as amended. According to the act, specified measuring instruments are instruments which are included in the list of the types of specified measuring instruments (Decree No 345/2002) and, at the same time, intended (by the manufacturer/importer) for measurements of relevance for the protection of public interests in *consumer protection, contractual relations, imposition of sanctions, fees, tariffs and taxes, health protection, environmental protection, occupational safety, or the protection of other public interests protected by separate legislation*. This means that their purpose is similar to that used for defining specified products – measuring instruments and non-automatic weighing instruments – under Directives 2014/31/EU and 2014/32/EU. The requirements of this regulation do not apply to measuring instruments placed on the market in the Czech Republic for purposes other than the above purposes defined by Act No 505/1990 on metrology.

The subject matter of this notified regulation is to lay down the metrological and technical requirements for specified measuring instruments of this type. This regulation also lays down the tests for the purposes of type approval and verification of specified measuring instruments of this type.

(End of executive summary)

PUBLIC NOTICE

The Czech Metrology Institute (CMI), as the body competent and relevant for the determination of metrological and technical requirements for a specified measuring instrument and for the determination of type approval tests and verification of a specified measuring instrument pursuant to Section 14(1) of Act No. 505/1990 On Metrology, as amended (Metrology Act), and pursuant to the provisions of sections 172 et seq. of Act No. 500/2004 Coll., the Administrative Procedure Code, as amended (hereinafter the “Procedure Code”), initiated on 21.12.2009 pursuant to Section 46 of the Procedure Code, and, based on supporting documents, issues the following:

I.

DRAFT GENERAL MEASURE

number:0111-OOP-C088-18

laying down metrological and technical requirements for specified measuring instruments, including the testing methods for verification of the following specified measuring instruments:

'current measuring transformers'

1 Basic definitions

For the purposes of this General Measure, terms and definitions pursuant to VIM and VIML[1] and the following must apply:

1.1
current transformer

an instrument transformer whose secondary current is proportional to the primary current, and has a phase angle difference of almost zero when properly connected

1.2
current instrument transformer (CIT)

a transformer whose secondary current is for practical purposes proportional to the primary current during normal operating conditions; the phase difference between the primary and secondary current vectors approaches zero when suitably connected

1.3
nominal primary current

the primary current value specified on the current transformer's nameplate and upon which its operation is based

1.4
nominal secondary current

the secondary current value specified on the current transformer's nameplate and upon which its operation is based

1.5
current error ε_I (conversion error)

the error the transformer introduces into current measurement and that follows from the fact that the actual conversion is not equal to the nominal conversion. This current error, expressed in percent, is given by the formula:

$$\varepsilon_I = \frac{(K_n I_s - I_p)100}{I_p} \ (\%) \qquad (1)$$

where K_n .... is the nominal conversion,
I_p .... is the real primary current,
I_s.......... is the real secondary current corresponding to the primary current I_p under measurement conditions.

1.6
angle error δ_I

the phase shift between the primary and secondary current phasor; the primary and secondary current phasor orientation are chosen so that an ideal transformer would exhibit zero error. The angle error is considered positive if the secondary current phasor I_s precedes the primary current phasor I_p. It is usually expressed in arcminutes or centiradians.

NOTE: This definition is correct only for AC power with a sinusoidal waveform.

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[1] TNI 01 0115 International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM) and International Vocabulary of Legal Metrology (VIML) are part of the technical harmonisation compendium ‘Terminology in the field of metrology’, which is publicly available at www.unmz.cz.

1.7
accuracy class
used to designate a current transformer whose current error and angle error do not exceed permitted values in prescribed operating conditions

1.8
transformer load
the impedance of the secondary circuit expressed in ohms for a given power factor The load is usually expressed as the apparent power in VA consumed at the stipulated power factor and at nominal secondary current.

1.9
nominal load
the load value upon which requirements for the stipulated accuracy are based

1.10
nominal apparent output
the value of the apparent output (in volt-amperes at a given power factor) that the transformer transfers to the secondary circuit at nominal secondary current and a connected nominal load

1.11
maximum device voltage
the maximum effective value of associated AC voltage for which the transformer is designed with respect to its insulation

1.12
nominal insulation level
a combination of voltage values that characterises the transformer's insulation from the standpoint of its ability to resist electrical stress

1.13
nominal frequency
the frequency value on which the requirements of this Measure are based

1.14
nominal transient thermal current (I_{th})
the effective primary current value that the transformer will withstand for one second during a short-circuited secondary winding without being damaged; times other than one second can be used, e.g. 0.5 s, 3 s, 5 s

1.15
nominal dynamic current (I_{dyn})
the peak value of primary current that the transformer will withstand without electrical or physical damage due to EM forces during a secondary winding short-circuit

1.16
nominal continuous thermal current
the value of the current that can permanently flow through the primary winding without causing the prescribed heating value to be exceeded when a nominal load is connected to the secondary winding

1.17
excitation current

the effective value of the current flowing through the secondary winding of the current transformer when a sinusoidal voltage at nominal frequency is applied to the secondary terminals, the primary and all other windings being open

1.18
total error

under steady state conditions, the effective value of the difference between instantaneous primary current values and instantaneous actual secondary current values multiplied by the nominal conversion; the positive sign of the primary and secondary current corresponds to agreed-upon terminal markings

In general, the total error ε_c is expressed as a percentage of the effective values of the primary current according to the following formula:

$$\varepsilon_c = \frac{100}{I_p}\sqrt{\frac{1}{T}\int_0^T \left(K_n i_s - i_p\right)^2 dt} \ (\%) \qquad (2)$$

where K_n .... is the nominal current transformer conversion;
I_p .... is the effective primary current;
i_p .... is the immediate primary current;
I_s .... is the immediate secondary current;
T .... is the duration of one cycle.

1.19
nominal primary overcurrent (IPL)

the value of the minimum primary current at which the total error of the current instrument transformer is greater than or equal to 10% at the nominal secondary load

NOTE: The total error should be greater than 10% in order to protect equipment powered by the instrument transformer from high currents under fault conditions.

1.20
overcurrent number (FS)

the ratio of the nominal primary overcurrent to the nominal primary current

NOTE: In the event that a short-circuit current flows through the primary winding of the current transformer, maximum safety will be provided to powered devices if the overcurrent number (FS) is small.

1.21
limit secondary electromotive voltage

the product of the overcurrent number, nominal secondary current and the vector sum of the nominal load and the secondary winding impedance

2 Metrological requirements

2.1 Normal operating conditions

2.1.1 Ambient temperature

Current transformers are classified into three categories, as shown in Table 1.

Table 1 - Temperature categories

Category	Lowest temperature (° C)	Highest temperature (° C)
-5/+40	-5	+40
-25/+40	-25	+40
-40/+40	-40	+40

NOTE: Storage and transport conditions must also be considered when selecting a temperature category.

2.1.2 Other operating conditions for indoor current transformers

Other operating conditions that are considered are as follows:

(a) the influence of solar radiation; may be neglected;

(b) the influence of ambient air if it is not heavily contaminated by dust, smoke, corrosive gases, vapours or salts; may be neglected;

(c) the effect of relative humidity may be neglected if the following conditions are met:

- the average relative humidity measured over 24 hours does not exceed 95%;
- the average water vapour pressure over 24 hours does not exceed 2.2 kPa;
- the average relative humidity over the course of one month does not exceed 90%;
- the average water vapour pressure over the course of one month does not exceed 1.8 kPa.

Under these conditions, condensation of water vapour may occasionally occur.

NOTE: To ensure immunity to high humidity and condensation that could cause insulation breakdown or corrosion of metal parts, a transformer designed for such conditions should be used.

2.1.3 Other operating conditions for outdoor CIT

Other operating conditions that are considered are as follows:

(a) if the average ambient air temperature measured over a period of 24 hours does not exceed 35 ° C, it can be neglected;

(b) solar radiation exceeding 1000 W/m^2 (at noon on a clear day) must be taken into account;

(c) the ambient air, if it is heavily contaminated by dust, smoke, corrosive gases, vapours or salts, must be taken into account;

(d) wind pressure not exceeding 700 Pa (this value corresponds to a wind speed of 34 m/s) is not taken into account;

(e) the presence of condensation or precipitation must be taken into account.

2.2 Nominal values of CIT parameters

2.2.1 Nominal primary current values

Single conversion transformers

The standardised values of nominal primary currents are as follows:

(<u>10;</u> 12.5; <u>15</u>; <u>20</u>; 25; <u>30</u>; 40; <u>50</u>; 60; <u>75</u>) A

and their decimal multiples or fractions. Underlined values are preferred.

Multiple conversion (winding) transformers

The values given in Article 2.2.1 apply to the lowest nominal primary current values.

2.2.2 Nominal secondary current values

The nominal secondary current values are 1 A, 2 A and 5 A; the preferred values are 5 A and 1 A.

NOTE: For transformers that are intended to be delta-connected in a group, these nominal values divided by √3 will also be standardised values.

2.2.3 Nominal continuous thermal current

Unless specified otherwise, the nominal continuous thermal current must be the nominal primary current (see Article 2.4.5).

2.2.4 Nominal load values

Nominal load values for instrument transformers up to 30 VA are as follows:

(2.5; 5,0; 10; 15; 30) VA. Values above 30 VA can be selected as needed.

For loads below 5 VA, a power factor of 1 is used, while for 5 VA and greater, a power factor of 0.8 is used.

2.3 Standardised values for transient currents

Current transformers with a primary winding consisting of a coil or a separate conductor must comply with the requirements of articles 2.3.1 and 2.3.2.

2.3.1 Nominal transient thermal current (I_{th})

The nominal transient thermal current (I_{th}) must be determined for each transformer (see Article 1.14), and this value must be indicated on the nameplate.

2.3.2 Nominal dynamic current (I_{dyn})

The value of the nominal dynamic current (I_{dyn}) must be 2.5 times the nominal transient thermal current (I_{th}) under the defined conditions, and if different from this value must be indicated on the nameplate (see 1.15).

2.4 Accuracy classes and permissible errors of current instrument transformers

2.4.1 Determination of the accuracy class of current instrument transformers

For current instrument transformers, the accuracy class is determined by the maximum permissible current error expressed as a percentage at the nominal current prescribed for the relevant accuracy class.

2.4.2 Standardised accuracy classes

Standardised accuracy classes for current instrument transformers are as follows:

0.1, 0.2, 0.2S, 0.5, 0.5S, 1.

2.4.3 Permissible current errors and angle errors for current instrument transformers

For classes 0.1, 0.2, 0.5 and 1, current error and angle error at rated frequency must not exceed the values in Table 2 when the secondary load is between 25% and 100% of the nominal load.

For classes 0.2S and 0.5S, current error and angle error at nominal frequency must not exceed the values in Table 2 when the secondary load is between 25% and 100% of the nominal load.

The secondary load used for test purposes for all accuracy classes must have an inductive power factor of 0.8, except when the load is less than 5 VA; in this case, a power factor of 1 must be used.

The test load must never be less than 1 VA.

NOTE: Generally permissible current errors and angle errors are given for arbitrary locations of an external conductor in the air at a distance greater than that required for the air separation distance at the highest voltage for the device (U_m see Table 4).

Table 2 - Maximum permissible current errors and angle errors for current instrument transformers

Accuracy class	± current error (ratio) as a percentage of the nominal current specified in the following row				± current error as a percentage of the nominal current specified in the following line							
					Minutes				Centiradians			
	5	20	100	120	5	20	100	120	5	20	100	120
0.1	0.4	0.2	0.1	0.1	15	8	5	5	0.45	0.24	0.15	0.1
0.2	0.75	0.35	0.2	0.2	30	15	10	10	0.9	0.45	0.3	0.3
0.5	1.5	0.75	0.5	0.5	90	45	30	30	2.7	1.35	0.9	0.9
1.0	3.0	1.5	1.0	1.0	180	90	60	60	5.4	2.7	1.8	1.8

Table 3 - Maximum permissible current and angle errors for special-purpose current instrument transformers

Accuracy class	± current error (ratio) as a percentage of the nominal current specified in the following row					± current error as a percentage of the nominal current specified in the following line									
						Minutes					Centiradians				
	1	5	20	100	120	1	5	20	100	120	1	5	20	100	120
0.2S	0.75	0.35	0.2	0.2	0.2	30	15	10	10	10	0.9	0.45	0.3	0.3	0.3
0.5S	1.5	0.75	0.5	0.5	0.5	90	45	30	30	30	2.7	1.35	0.9	0.9	0.9

2.4.4 Extended load range

For all transformer accuracy classes whose permissible errors are given in tables 2 and 3, an extended load range may be defined. In this case, these permissible errors must apply to loads in the range of 1 VA up to the nominal value at a power factor of 1.The maximum nominal load is limited to 15 VA.

2.4.5 Extended current range

Current transformers of accuracy classes 0.1 to 1 may be designated as extended current range transformers if they meet the following requirements:

a) the nominal continuous thermal current must be the nominal extended primary current expressed as a percentage of the nominal primary current;

b) the permissible current errors and angle errors specified at 120% of the nominal primary current in Table 2 must be ensured up to the nominal extended primary current.

The extended primary current is to be expressed as a percentage of the nominal value of the primary current (e.g. 150% I_N).

3 Technical requirements

3.1 Insulation requirements

These requirements apply to all CIT types.

3.2 Nominal insulation levels for the primary winding

The highest voltage for the device is selected as the nearest standardised value U_m greater than or equal to the maximum voltage of the system in which the device is installed. The standardised values U_m must be selected from Table 4.For CITs installed in normal ambient conditions related to insulation, U_m must be at least equal to the maximum voltage of the grid U_{sys}. For a device installed outside range of normal ambient conditions related to insulation, the value U_m may be selected higher than the nearest standardised value U_m, equal to or greater than U_{sys} according to special needs. For plug-in CITs without primary conductor insulation, U_m = 0.72 kV.

NOTE: For example, choosing U_m higher than the nearest standardised value U_m greater than or equal to U_{sys} when the instrument transformer is to be installed at an altitude greater than 1,000 metres a.s.l. to compensate for the drop in the withstand voltage of the external insulation.

Table 4 - Prescribed primary terminal insulation levels for instrument transformers

Maximum device voltage U_m (effective value) kV	**Nominal power-frequency withstand voltage (effective value) kV**	**Nominal atmospheric impulse withstand voltage (peak value) kV**	**Nominal switching impulse withstand voltage (peak value) kV**
0.72	3	---	---
1.2	6	---	---
3.6	10	20	---
		40	---
7.2	20	40	---
		60	---
12	28	60	---
		75	---
17.5	38	75	---
		95	---
24	50	95	---
		125	---
36	70	145	---
		170	---
52	95	250	---
72.5	140	325	---
100	185	450	---
123	185	450	---
	230	550	---
145	230	550	---
	275	650	---
170	275	650	---
	325	750	---

continued

Table 4 – continued

Maximum device voltage U_m (effective value) kV	Nominal power-frequency withstand voltage (effective value) kV	Nominal atmospheric impulse withstand voltage (peak value) kV	Nominal switching impulse withstand voltage (peak value) kV
245	395	950	---
	460	1,050	---
300	395	950	750
	460	1,050	850
362	460	1,050	850
	510	1,175	950
420	570	1,300	950
	630	1,425	1,050
550	630	1,425	1,050
	680	1,550	1,175
800	880	1,950	1,425
	975	2,100	1,550

3.3. Requirements for secondary windings insulation and external insulation

3.3.1 Requirements for insulation between winding sections

For primary and secondary windings divided into two or more sections, the insulation between the sections must withstand a effective nominal transient power-frequency AC voltage of 3 kV.

3.3.2 Secondary winding insulation requirements

The insulation of secondary windings must withstand a nominal transient power-frequency voltage AC of 3 kV.

3.3.3 Coil insulation requirements

The nominal withstand voltage of coil insulation must be 4.5 kV (peak value).
For some types of transformers, lower values may be allowed in accordance with the test procedure in Article 5.10.

NOTE: The test procedure may cause the waveform to be highly distorted.

3.3.4 External insulation requirements in the event of soiling

For current transformers for outdoor use with a ceramic insulator sensitive to soiling, Table 5 lists the required insulation distances measured across the insulator surface for individual degrees of soiling.

Table 5 - Insulation distances in the event of soiling

Degree of soiling	Minimum nominal surface distance mm/kV[1)]	Surface to arcing distance ratio
I low II medium	16 20	≤3.5
III high IV very high	25 31	≤4.0
[1)]The ratio of surface distance between phase and ground to the device's highest effective voltage.		

NOTES:

1. It is found that the quality of the surface insulation is greatly influenced by the shape of the insulator.
2. In very lightly soiled areas, specific insulation distances below 16 mm/kV can be used down to a limit value of 12 mm/kV.
3. In cases of exceptionally heavy soiling, even a specific insulation value of 31 mm/kV may not suffice. Depending on operating experience or laboratory tests, an even higher specific insulation distance may be used. In some cases insulators can be washed.

3.3.5 Altitude above sea level

For installations more that 1,000 m above sea level, the arcing distance determined for normal reference atmospheric conditions must be recalculated by multiplying the withstand test voltage required for a given installation site by a correction factor *k* according to the following formula.

Factors are calculated according to the following formula:

$$k = e^{m(H - 1000)/8150} \tag{3}$$

where H is altitude above sea level (m);
$m = 1$ for grid frequency and an atmospheric impulse;
$m = 0.75$ pro a switching impulse.

3.4 Partial discharge requirements

Partial discharge requirements are for current transformers with $U_m \geq 7.2$ kV. Partial discharge levels must not exceed those in Table 6.

Table 6 - Test voltages for measuring partial discharges and permissible levels

Network ground type	Test voltage for partial discharge measurement (effective value) kV	Permissible partial discharge levels pC	
		Insulation type	
		Windings submerged in oil	Dry insulation
Network with ground node (ground fault coefficient ≤ 1.4)	U_m	10	50
	$1.2\ U_m/\sqrt{3}$	5	20
Grid with insulated or non-effective ground node (ground fault coefficient > 1.4)	$1.2\ U_m$	10	50
	$1.2\ U_m/\sqrt{3}$	5	20

NOTES:

1. If the grounding type is not defined, the values for an insulated or non-effectively grounded network apply.
2. Permissible partial discharge levels also apply for measurements with a frequency other than the nominal frequency.

4 Measuring instrument markings

4.1 Terminal markings

Terminal markings must identify:

a) primary and secondary windings;
b) winding sections, if any;
c) relative polarity of windings and winding sections;
d) centre taps, if any.

4.2 Marking method

Terminals must be clearly and indelibly marked either on their surface or in their immediate vicinity. Markings must consist of letters followed by numbers, or preceded if necessary. Capital block letters of the alphabet must be used.

4.3 Markings used

Preferred current transformer terminal markings are shown in Figure 1.

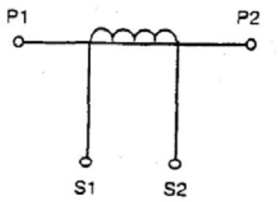
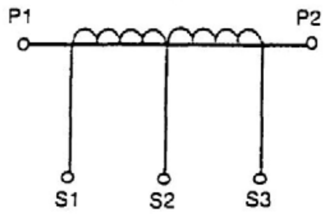
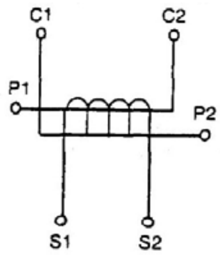
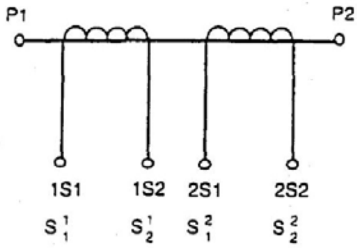
Primary terminals Secondary terminals	 **a) Single-conversion transformer**	 **b) Transformer with a centre tap on the secondary winding**
Primary terminals Secondary terminals	 **c) Transformer with the primary winding configured in two sections for serial or parallel connection**	 **d) Transformer with two secondary windings; each has its own magnetic core.(Two alternative markings for secondary terminals.)**

Figure 1 - Terminal markings

4.4 Polarity indication

All terminals marked P1, S1 and C1 must have the same polarity at the same time.

4.5 Information on the nameplate

All current transformers must have a nameplate bearing at least the following information:

a) the manufacturer's name or trade mark;
b) year of manufacture and serial number and type designation;

c) nominal primary and secondary currents, i.e.:
   $K_n = I_{pn} / I_{sn}$ A (e.g. K = 100 A/5 A),
   where I_{pn} a I_{sn} is the transformer's nominal primary/secondary current;
d) nominal frequency (e.g. 50 Hz);
e) nominal load and the corresponding accuracy class together with the additional information specified in this measure (see Article 2.4.5);
f) maximum device voltage (e.g. 1.2 kV or 145 kV);
g) nominal insulation level (e.g. 6/20 kV or 275/650 kV);
h) nominal transient thermal current (I_{th}) and nominal dynamic current if it is not 2.5 times the nominal transient thermal current (e.g. 13 kA or 13/40 kA);
i) insulation class, if different from Class A;
j) temperature category;
k) weight in kg.

NOTE:

Items f) and g) can be combined into one marking (e.g. 1.6 kV or 145/275/650 kV).

If several classes of insulating materials are used, the one that limits winding warming is given. In the case of transformers with two windings, each winding and its corresponding terminals are marked.

All information must be indelibly marked on the current transformer or on a nameplate attached to the transformer.

4.6 Additional requirements for information on current instrument transformer nameplates

The marking plate must contain relevant information pursuant to Article 4.5.The accuracy class and the overcurrent number must be indicated after the nominal load (e.g. 15 VA; class 0.5; FS 10).Current transformers with an extended current range (see 2.4.5) must have this information immediately after the class information (e.g. 15 VA; class 0.5; ext.150%).

NOTE The label may contain information regarding several load and accuracy class combinations that the transformer can comply with (e.g. 15 VA, class 0.5 - 30 VA, class 1) and in this case non-standardised load values that can be used (e.g. 15 VA, Class 1 - 7 VA, Class 0.5 in accordance with the note for Article 2.4.4).

5 Measuring instrument type approval

The type approval process for instrument transformers includes the following tests and activities:

5.1 Transient current test

For the test involving transient thermal current I_{th}, the transformer must be at a starting temperature between + 10 °C and + 40 °C. This test must be performed with a shorted secondary winding and a current of I for t such that the product of I^2 t will not be less than I^2_{th} and time t will be between 0.5 s and 5 s.

The dynamic test must be carried out with shorted secondary windings and with a peak current value not less than the nominal dynamic current I_{dyn} at least the first peak. This dynamic test may be combined with the aforementioned thermal test performed so that the first highest peak of the current in the test will not be less than the nominal dynamic current I_{dyn}. The transformer has passed the test if, after cooling to an ambient temperature between +10 °C and +40 °C, it meets the following requirements:

a) it is not visibly damaged;
b) its demagnetisation errors do not differ from the errors recorded before the tests by more than half of the limit errors in its accuracy class;

c) it passes dielectric tests pursuant to Articles 5.10, 5.11 and 5.12 with test voltages reduced to 90% of the prescribed values;

d) inspection of insulation next to the lead surfaces reveals no significant damage (e.g. charring).

Inspection pursuant to d) is not required if the current density in the primary winding corresponding to the nominal transient thermal current I_{th} does not exceed 180 A/mm^2 in the case of copper windings, or 120 A/mm^2 in the case of aluminium windings.

5.2 Temperature rise test

For this test, it is stipulated that the transformer has reached a steady state if the temperature increment per hour is not greater than 1 K. The ambient temperature at the test site must be between +10 °C and +30 °C. In this test, the transformer must be assembled in the same way as it will be in operation. Winding temperature rise must be determined from changes in resistance; for windings with very low resistance, thermocouples can be used. The temperature rise of parts other than windings can be measured using thermometers or thermocouples. The temperature rise of windings, magnetic circuits or any other parts must not exceed the values in Table 7.

Table 7 – Temperature rise limits for different parts, materials and dielectrics of CIT

Part of the instrument transformer	**Temperature rise limits** (K)
1. Oil-filled instrument transformers − oil in the top layer - oil in the top layer, hermetically sealed − centre of winding - centre of winding, hermetically sealed− other metal parts in contact with oil	50 – 60 – 65 55 − as for windings
2. Instrument transformers with solid or gas insulation − windings (average value) in contact with insulating materials according to the following classes: Y − A − E − B − F − H − other metal parts in contact with the above material classes	45 − 60 − 75 – 85 − 110 − 135 − as for windings
3. Connections, screw or equivalent − bare copper, bare copper alloy or bare aluminium alloy	
• in air • in SF6 • in oil − silver plated or nickel plated	50 75 60
• in air • in SF6 • in oil − tinplate	75 75 60
• in air • in SF6 • in oil	65 65 60

5.3. Impulse voltage primary winding test

The test voltage must be applied between the primary winding terminals (interconnected) and ground. The frame, case (if present) and core (if it is to be grounded) and all secondary winding terminals must be grounded. Pulse tests generally consist of applying reference and test impulses. The reference impulse voltage must have an amplitude between 50% and 75% of the nominal test voltage. The peak value and the shape of the voltage pulse must be recorded during the test. Proof of failure is given by the change in the shape of the reference and test voltage pulses. For fault detection, currents flowing to ground during the test can be recorded to supplement voltage recording.

5.3.1 Atmospheric impulse test

The test voltage must have an appropriate value pursuant to Table 4 according to the highest voltage for the device and the specified insulation level.

5.3.1.1 Windings with U_m < 300 kV

The test must be performed using both positive and negative polarity impulses. Fifteen consecutive impulses of each polarity are applied with no correction for atmospheric conditions. The transformer has passed the test if for both polarities:

a) non-self-restoring internal insulation was not breached;
b) no arc occurred along non-self-restoring external insulation. This is confirmed via five consecutive withstand impulses after the last arc;
c) no more than two arcs occurred along non-self-restoring external insulation;
d) no other evidence of insulation fault was found (for example no changes in shape occurred during the course of recorded values).

If arcs have occurred and evidence cannot be provided during the test that they occurred in self-restoring insulation, the instrument transformer must be removed and inspected after the dielectric tests have been completed. If damage to non-self-restoring insulation is observed, the instrument transformer has failed the test.

NOTE: The application of 15 positive and 15 negative impulses is stipulated for external insulation testing. If the manufacturer and the customer have agreed on additional testing of external insulation, the number of atmospheric impulses may be reduced to three impulses of each polarity without correction for atmospheric conditions.

5.3.1.2 Windings with $U_m \geq 300$ kV

The test must be performed using both positive and negative polarity. Three consecutive impulses of each polarity are applied with no correction for atmospheric conditions.

The transformer has passed the test if:

a) no arcs occurred;
b) there is no other evidence of insulation faults.

5.3.2 Switching impulse test

The test voltage must have the appropriate value pursuant to Table 4 according to the highest voltage for the device and the specified insulation level.

The test must be performed using positive polarity. Fifteen consecutive impulses of each polarity with correction for atmospheric conditions are applied to the transformer. For outdoor transformers, the test must be carried out in rain (see 5.4).The transformer has passed the test if:

a) non-self-restoring internal insulation was not breached;
b) no arc occurred along non-self-restoring external insulation;
c) no more than two arcs occurred along non-self-restoring external insulation;
d) no other evidence of insulation fault was found (for example no changes in shape occurred during the course of recorded values).

If arcs have occurred and evidence cannot be provided during the test that they occurred in self-restoring insulation, the CIT must be removed and inspected after the dielectric tests have been completed. If damage to non-self-restoring insulation is observed, the CIT has failed the test.

NOTE: Impulses during which arcs occurred to the walls or ceiling of the laboratory are not taken into account.

5.4. Outdoor transformer rain test

For windings with U_m < 300 kV, the test must be carried out with power-frequency AC voltage and the test voltage in Table 4 as a function of the maximum voltage for the device, corrected for atmospheric conditions.

For windings with $U_m \geq$ 300 kV, the test must be carried out with positive switching impulses and the test voltage in Table 4 as a function of the maximum voltage for the device and at the nominal insulation level.

5.5 Electromagnetic compatibility (EMC) test - radio interference voltage (RIV) measurement

RIV requirements apply to instrument transformers with $U_m \geq$ 123 kV that will be installed in air-insulated substations.

Because interfering RF voltages may be affected by fibres or dust deposited on insulators, they may be wiped with a clean cloth prior to the start of measurement.

The following procedure must be followed:

The instrument transformer with accessories must be dry and clean and at approximately the same temperature as the laboratory where the test is performed. The test is performed under the following atmospheric conditions:

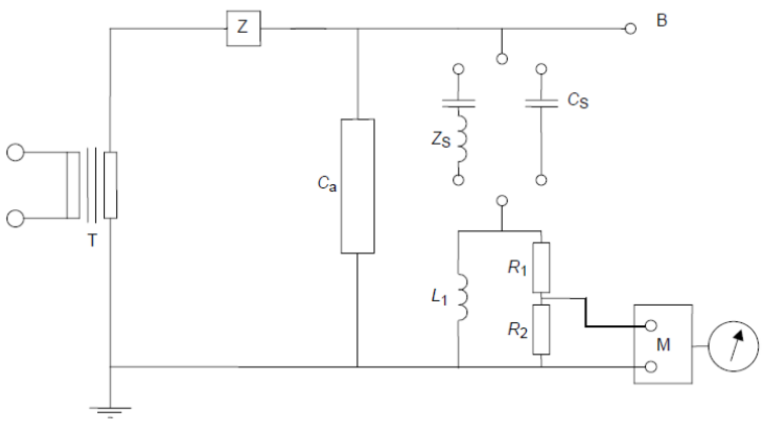
Ambient temperature:10 °C to 30 °C

Atmospheric pressure:($0.870 \cdot 10^5$ to $1.07 \cdot 10^5$) Pa

Relative humidity:45% to 75%

The test leads and their ends must not be a source of radio-frequency interference.

In order to avoid interfering discharges from the primary terminals, they must be appropriately shielded by imitating service shielding. It is recommended to use a length of pipe with a spherical end.



Legenda

T zkušební transformátor

C_a zkoušený předmět

Z filtr

B svorka s ochranou proti vzniku korony

M měřicí souprava se vstupním odporem R_M

$$Z_S + \left(R_1 + \frac{R_2 \cdot R_M}{R_2 + R_M}\right) = 300\ \Omega$$

Z_S, C_S, L_1, R_1, R_2 viz CISPR 18-2

Legenda	Legend
zkušební transformátor	test transformer
zkoušený předmět	tested item
filtr	filter
svorka s ochranou proti vzniku korony	terminal with protection against corona formation
měřicí souprava se vstupním odporem R_M	measuring equipment with input resistance R_M
Z_S, C_S L_1, R_1, R_2 viz CISPR 18-2	Z_S, C_S L_1, R_1, R_2 see CISPR 18-2

Figure 2 - Electromagnetic compatibility test arrangement

As shown in Figure 2, the test voltage is applied between one of the primary winding terminals of the test item (C_a) and ground. The frame, cover (if any), core (if it is intended to be grounded) and one terminal of each secondary winding are grounded.

The measuring circuit must be tuned in the 0.5 MHz to 2 MHz band with measurement frequency recording. Results are expressed in microvolts.

The impedance between the test lead and ground, ($Z_S + (R_1 + R_2 // R_M)$) in Figure 3, must be 300 Ω ± 40 Ω with a phase angle not exceeding 20° at the measurement frequency.

Capacitor CS may also be used instead of filter ZS; sufficient capacity is 1,000 pF.

Filter Z must have a large impedance at the measuring frequency to separate the power-frequency source from the measuring circuit. A suitable value for this impedance at the measuring frequency can be found from 10,000 Ω to 20,000 Ω.

The background noise level of high-frequency interference (RF interference caused by an external field and a high-voltage transformer) must be at least 6 dB (preferably 10 dB) below the given level of radio interference.

The test voltage is applied between one of the primary winding terminals of the test item (C_a) and ground. The frame, cover (if any), core (if it is intended to be grounded) and one terminal of each secondary winding are grounded.

Prior to the measurement itself, a voltage of $1.5 \times U_m/\sqrt{3}$ is applied and maintained for 30 seconds. The voltage is then reduced to $1.1 \times U_m/\sqrt{3}$ for approximately 10 seconds, and is maintained at this value for 30 seconds prior to the actual RF interference measurement.

The instrument transformer is deemed to have passed this test if the RF interference does not exceed 2500 μV at $1.1\ U_m/\sqrt{3}$.

5.6 Accuracy tests

Type tests to verify the requirements of Article 2.4.3 for transformers of classes 0.1 to 1 must be performed for each of the current values in Table 2 at 25% and 100% of the nominal load (provided that 1 VA is the minimum load).Transformers with an extended current range greater than 120% must be tested at the nominal extended primary current instead of at 120% of nominal current.

In the case of extended load range, the accuracy test must be performed for 1 VA and for 100% of the nominal load at a power factor of 1.The maximum rated load in this case is limited to 15 VA.

5.7 Terminal markings check

This test is performed pursuant to Article 4.2.

5.8 Primary winding AC test

The test voltage must have the appropriate value (according to Table 4) depending on the maximum voltage for the device. The duration of the test must be 60 seconds. The test voltage must be applied to the shorted primary winding and ground. The short-circuited secondary winding, the frame, the casing (if any) and the core (if it has a separate ground terminal) must be grounded.

5.9 AC test of the secondary winding and between winding parts

A 3 kV test voltage must be applied for 60 seconds between the shorted terminals of each winding section or each secondary winding and ground.

5.10 Inter-turn insulation surge test

An inter-turn insulation surge test must be performed using one of the methods below. Unless otherwise agreed, the manufacturer chooses one of these methods.

Method A:
When the secondary windings are disconnected (or connected to a high-impedance device that records the peak value), a sinusoidal current of frequency between 40 Hz and 60 Hz is applied to the primary winding for 60 seconds at an effective value corresponding to the nominal primary current (or the nominal increased primary current [see Article 2.4.5] if this current comes into consideration).The current used must be limited if a peak test voltage of 4.5 kV is reached before the nominal current (or nominal increased current) is reached.

Method B:
If the primary winding terminals are open, the specified test voltage of 50 Hz to 400 Hz must be connected to the terminals of each secondary winding for 60 seconds, provided that the effective value of the secondary current does not exceed the nominal secondary current (or nominal increased current).If at this frequency the peak voltage reached at the nominal secondary current (or increased current) is less than 4.5 kV, then this voltage is considered to be the test voltage. If the frequency exceeds double the nominal frequency, the test period may be reduced to less than 60 seconds according to the following relationship:

$$trvání\ zkoušky\ (s) = \frac{dvojnásobek\ \ jmenovité\ \ frekvence}{zkušební\ \ frekvence} \times 60\,,$$

but to no less than 15 seconds.

5.11 Partial discharge measurement

5.11.1 Test circuit and measuring equipment

The measuring equipment must measure the apparent charge *Q* expressed in pico coulombs (pC).It must be calibrated after it is connected to the test circuit. Broadband equipment must have a minimum bandwidth of 100 kHz with an upper frequency not exceeding 1.2 MHz. Narrowband equipment must have its resonant frequency within 0.15 MHz to 2 MHz. A range of 0.5 MHz to 2 MHz is recommended, but if feasible, measurements will be made at the frequency that provides the greatest sensitivity. Sensitivity must allow detection of partial discharges with an amplitude of 5 pC.

NOTES:

1. Interference must be significantly lower than the indicated sensitivity. Known impulses caused by external interference are not considered.
2. Bridge connection can be used to suppress external interference.
3. If equipment allowing electronic interference suppression is used, it must be proven by means of changes to its parameters that it allows the detection of repeated impulses.

5.11.2 Partial discharge measurement procedure

After pre-test stress using Method A or Method B, the test voltage is increased to the test voltage value for partial discharge measurement in Table 6 and partial discharge measurements are made at this level for 30 seconds. The partial discharge level must not exceed the values in Table 6.

Method A:
The voltage level is reached while the voltage is being reduced after the applied power-frequency voltage test.

Method B:
Partial discharge measurements are made after the applied power-frequency voltage test. The voltage is increased to 80% of the test voltage for the applied power-frequency voltage test, allowed to remain at that level for at least 60 seconds and reduced to the partial discharge voltage without interruption.

Unless otherwise stipulated, the manufacturer chooses one of these methods. The test method chosen must be specified in the test report.

6 Initial verification

The following tests must be carried out during the verification of current instrument transformers:

a) a technical inspection and check that terminals are marked correctly;
b) determination of the transformer's current and angle errors.

6.1 Required tools

The following test equipment is used to test transformers:

6.1.1 Measuring set-up

The measuring set-up consisting of a reference measuring device for evaluating the difference in errors between the reference and the tested CIT, a reference current instrument transformer or a reference current comparator for current transformer loads, auxiliary measuring instruments for measuring current, frequency and distortion, and of regulated power circuitry.

6.1.2 Set-up for demagnetising current instrument transformers

A set-up comprising a power supply with regulation, an ammeter or a current measuring shunt, a voltage divider with a voltmeter to measure the peak and mean voltage or an oscilloscope

6.1.3. Set-up to determine additional supply cable resistances

A set-up that allows measurement with an accuracy of 3 or better (e.g. a digital multimeter with four-terminal resistance measurement, i.e. a 4-wire connection).

6.1.4 Current instrument transformer loads

Loads with a power factor of cos β = 0.8 or cos β = 1 must be used, specified for the given frequency, allowing the nominal value, given by the combination of the actual load, the impedance of the measuring device and the supply cables, to be set with the appropriate error. Current instrument transformer loads (see section 2.2.4) with a value of Z <5 VA must have a power factor of cos β = 1.For the measurement of errors of transformers with extended load range, a load with power factor cos β = 1 up to $Z \leq 15$ VA must be used.

6.1.5 Power supplies

Power supplies with harmonic current control over the required range must be used, with appropriate adjustment accuracy, stability and distortion of less than 5%.

6.1.6 Distortion measuring instrument

A distortion measuring instrument is used to monitor the current curve so that the distortion is less than 5%.

6.2 Conditions during tests

Current instrument transformers are tested at the nominal frequency with a maximum deviation of ± 1%, at a current harmonic whose distortion factor does not exceed 5%, an ambient temperature of +15 °C to +25 °C, relative air humidity of no more than 75% and an external magnetic field up to 1 mT.

6.3 Description of tests

6.3.1 Physical damage

Current instrument transformers are checked for physical damage, that nameplate information is complete, correct and legible, and that terminals are properly connected.

6.3.2 Correct marking of terminals

When checking whether terminals are marked correctly, the tested and reference transformer are connected in the measuring set-up so that the primary current in the windings of both transformers flows in the same direction (this corresponds the P2 or L terminal of the reference being connected in series with the P1 or K terminal of the tested CIT or vice versa).The secondary terminals of the two transformers are connected to identically marked measuring equipment terminals. If errors can be measured by the measuring equipment when the primary current is set to 10% I_{1N}, the terminals are marked correctly. Otherwise, the CIT is excluded from further testing.

6.4 Demagnetisation of the CIT

6.4.1 Demagnetisation

Current instrument transformers to be tested must be demagnetised prior to measurement by any of the methods specified in Article 6.4.2.a) or 6.4.2.b) if it is evident that the CIT has been magnetised prior to measurement. In other cases, demagnetisation is only performed if errors measured for the CIT do not correspond to required values.

6.4.2 Demagnetisation procedure

a) The primary or secondary winding of the CIT (usually the winding with the highest number of turns) is connected to a current source with a harmonic waveform (implemented for example by a voltage source and a series resistor) and nominal frequency. The other windings must be disconnected. The power supply current is increased slowly until it reaches the nominal value of the winding used, or until the peak voltage value on the open winding with the highest number of turns, measured by a peak voltmeter, reaches 3 kV for current transformers. The power supply current is then slowly and smoothly decreased to zero. If it is not possible to guarantee an ideally continuous decrease of the demagnetisation current (e.g. using a regulating transformer), it is necessary to configure the demagnetisation circuit so that the last step to zero current is not greater than 0.1% of the maximum current used during demagnetisation.

NOTE: When measuring voltage, the measuring winding must not be loaded by current greater than 0.1% of the nominal value.

b) The CIT to be tested is connected as in Article 6.4.2(a).The supply current is slowly increased as long as the mean voltage measured at any other winding keeps increasing (e.g. if a 10% increase in magnetising current corresponds to an increase in the mean induced voltage greater than 1%), or when the peak voltage value (or the magnitude of the demagnetising current) does not reach values as in Article 6.4.2(a).Subsequent steps are the same as in Article 6.4.2(a).

NOTE: The state where the ferromagnetic working point moves along the hysteresis loop boundary can also be determined by means of an oscilloscope, when the area of the half-wave of the induced voltage does not change significantly when the magnetising current increases.

6.4.3 Demagnetisation of multi-core transformers

For multi-core transformers, each core must be demagnetised.

6.4.4 Demagnetisation of the reference transformer

The reference CIT in the measuring set-up must be demagnetised during the test after every sudden current interruption, or if results indicate that it may be magnetised.

6.5 Determination of current and angle errors of current instrument transformers

6.5.1 Determination of errors

The basic arrangement for determining the error of a current instrument transformer is shown in Figure 3.

Current and angle errors are read on the set-up's measuring device, and if needed corrected for errors in the reference and the measuring equipment.

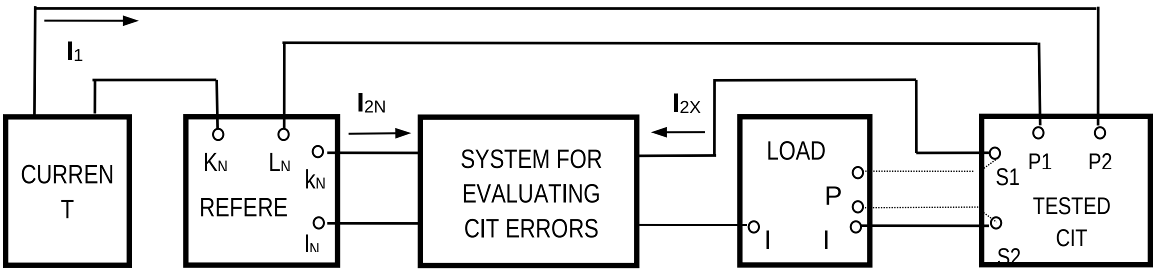


Figure 3 - Basic arrangement for determining current instrument transformer errors

If the errors of the reference transformer are known, the transformer under measurement is corrected according to the following relationship relationship:

$$\varepsilon_{IX} = \varepsilon_{IN} + \varepsilon_{IM} , \delta_{IX} = \delta_{IN} + \delta_{IM},(4)$$

where ε_{IX} and δ_{IX} are the errors of the transformer under measurement (%; '),
ε_{IN} and δ_{IN} are the errors of the reference transformer (%; '),
ε_{IM} and δ_{IM} are system data for error evaluation (%; ').

The errors of current instrument transformers are determined first at the maximum value of the measuring range (e.g. 120% I_{1N}).Then lower current values are used, according to Table 2 or Table 3.The reason is that the transformer can be demagnetised during measurement. Permissible CIT error limits at prescribed measuring points of accuracy class 0.1; 0.2; 0.5 and 1 are shown in Table 2, and for CIT accuracy classes of 0.2S and 0.5S in Table 3.

Transformer errors are measured at 25% of the nominal load and at the nominal load. The secondary load used for test purposes for all accuracy classes must have an inductive power factor of 0.8, except when the load is less than 5 VA; in this case, a power factor of 1 must be used.

If the transformer has an extended load range, transformer errors at 1 VA and nominal load are measured. For the measurement of errors of transformers with extended load range, a load with power factor cos $\beta = 1$ up to $Z \leq 15$ VA is used. The maximum rated load in this case is limited to 15 VA.

6.5.2 Extended range current transformer errors

For extended range transformers, current and angle errors are determined at the maximum value of the extended range nominal current (instead of at 120% I_{1N}).The measured errors must not exceed the values applicable to 120% I_{1N}.

6.5.3 Determining multi-core transformer errors

In the case of current instrument transformers with two or more cores, current and angle errors corresponding to the windings (transformers) on the individual cores are determined sequentially, with the windings that are not being tested short-circuited. Errors must be within permissible errors pursuant to Table 2 or Table 3.

6.5.4 Determination of errors for transformers with a split magnetic circuit

In the case of CIT with a split magnetic circuit, it is necessary that it has been sealed and secured properly.

6.5.5 Determination of errors for multiple conversion transformers

For multiple conversion current transformers, current and angle errors are determined for all nominal conversions and for primary current values in Table 2 or Table 3 and the CIT type. When testing in-service CITs (especially VHV), it is permissible to determine current and angle errors only for the conversion for which the CIT is connected.

6.5.6 Requirements for setting primary current and load

The primary current set at the individual measured points must be guaranteed with an error not exceeding 0.5% of the nominal current in the range of measured currents 120% to 20% and 0.3% of the nominal current in the range of measured currents 5% to 1%.Errors in the absolute value of loads for CITs must not exceed 3% of the nominal value. Errors in real and imaginary components of general-type loads must not exceed 3% of nominal values.

6.5.7 Errors in current transformers with accessories

The maximum permissible current and angle errors must not be exceeded for CITs with connected accessories if they are an integral part of the transformer.

6.6 Determination of current and angle errors of combined instrument transformers

6.6.1 Requirements for combined transformer current errors

For combined current and voltage operating transformers, the current transformer must comply with the conditions specified in Article 6.5, depending on design.

6.6.2 Transformer interaction

For combined instrument transformers, the interaction of both transformers must be determined when measuring errors:

a) The effect of the current transformer on the voltage transformer;
b) Thee effect of the voltage transformer on the current transformer.

6.6.3 Procedure used to determine transformer interaction

a) The effect of the current transformer under test on the voltage transformer under test is determined by determining the voltage and angle error of the tested voltage transformer:
- With the primary terminals of the current transformer disconnected;
- At a primary current of 120% of I_{1N} (or at the extended range current) and at 25% and 100% of the nominal secondary load Z_N.

b) The effect of the voltage transformer under test on the current transformer under test is determined by determining the voltage and angle error of the tested current transformer:
- With the primary terminals of the voltage transformer disconnected;
- At a primary voltage of 120% U_{1N} and at 25% and 100% of the nominal secondary load.

6.6.4 Permissible errors due to interaction

The detected current, voltage and angle errors of a combined measuring transformer due to interaction must comply with the conditions specified in Article 6.5 for separate error detection.

7 Subsequent verification

Subsequent verification is carried out in the same way as the initial verification in chapter 6.

8 Measuring instrument check

When examining measuring instruments pursuant to Section 11a of the Metrology Act at the request of a person who may be affected by an incorrect measurement, please proceed according to Chapter 7.The maximum permissible error used is 1.25 times the maximum permissible errors pursuant to Chapter 7.

9 Notified standards

For the purposes of specifying the metrological and technical requirements for measuring instruments and specifying the testing methods for their type approval and verification arising from this general measure, the CMI shall notify Czech technical standards, other technical standards or technical documents of international or foreign organisations, or other technical documents containing more detailed technical requirements (hereinafter referred to as ‘notified standards’).The CMI shall publish a list of these notified standards attached to the relevant measures, together with the general measure, in a manner accessible to the public (on www.cmi.cz).

Compliance with notified standards or parts thereof is considered, to the extent and under the conditions stipulated by a general measure, to be compliance with the requirements stipulated by this measure to which these standards or parts thereof apply.

Compliance with notified standards is one way of demonstrating compliance with the requirements. These requirements may also be met by using another technical solution guaranteeing an equivalent or higher level of protection of legitimate interests.

II.

G R O U N D S

Pursuant to Section 14(1)(j) of the Metrology Act, the CMI has issued this Measure of a General Nature toward the implementation of Section 6(2), Section 9(1) and (9), and Section 11a(3) of the Metrology

Act, laying down metrological and technical requirements for specified measuring instruments and tests for type approval and verification of specified measuring instruments - 'current instrument transformers'.

Decree No 4.1.4 specifying measuring instruments for mandatory verification and measuring instruments subject to type approval, as amended, classifies the measuring instruments under Item 4.1.4 in the annex entitled ‘List of specified measuring instruments’ as measuring instruments subject to type approval and mandatory verification.

This legislation (Measure of a General Nature) will be notified in accordance with Directive (EU) 2015/1535 of the European Parliament and of the Council of 9 September 2015 laying down a procedure for the provision of information in the field of technical regulations and of rules on Information Society services.

III.

I N S T R U C T I O N S

In accordance with Section 172(l) APC in conjunction with Section 39(l) APC, the CMI has stipulated a time limit for comments of 30 days as of the date of posting the draft on the official notice board. Comments submitted after this time limit will not be considered.

The persons concerned are hereby invited to comment on this draft Measure of a General Nature. With regard to the provisions of Section 172(4) APC, comments are to be submitted in writing.

Pursuant to the provisions of Section 174(1) APC, in conjunction with the provisions of Section 37(1) APC, it must be clearly stated who is submitting the comments, which general measure the comments concern, how the draft contradicts legislation or how the general measure is inaccurate. The comments must also contain the signature of the person making the comments.

The supporting documents for this draft general measure may be consulted at the Czech Metrology Institute, Legal Metrology Department, Okružní 31, 638 00 Brno, after making arrangements by telephone.

This draft general measure shall be posted for 15 days.

Czech Metrology Institute

Director General