Republic of Kosovo

Republic of Kosovo - Republika Kosova

Government - Qeveria -Vlada

Ministry of Trade and Industry - Ministria e Tregtisë dhe Industrisë - Ministarstvo Trgovine i Industrije

Pursuant to Article 93 paragraph 4 of the Constitution of the Republic of Kosovo, article 4, paragraph 4, sub-paragraph 4.1 and article 46 of Law No.03/L-203 of Metrology, and article 8 paragraph 1 sub-paragraphs 1.4. and annex 8 of Regulation No.02/2011 for Areas of Administrative Responsibility of the Office of the Prime Minister and Ministers, the Ministry of Trade and Industry issues this:

ADMINISTRATIVE INSTRUCTION NO. 03/2011

ON TECHNICAL AND METROLOGICAL REQUIREMENTS FOR LIQUID IN GLASS THEROMETERS

Article 1
Purpose

1. This administrative instruction sets out technical and metrological requirements for liquid in glass thermometers, for general purposes.

2. The provisions of this instruction are applicable for the liquid in glass thermometers, divided into six classes of accuracy, provided for various laboratory purposes in the laboratory range of temperature - 200 ° C up to + 500 ° C.

Article 2
Scope of Application

1. Liquid in glass thermometers in glass are used as reference or standard thermometers to measure the temperature in working environments, for the verification and calibration of thermometers, and also to define the conditions necessary for the assessment of the performance of other measuring instruments in legal and industrial metrology.

2. Liquid in glass thermometers are also used in clinical laboratories during the analysis of blood, enzymes and other clinical tests.

Article 3
Definition of Terms

1. Terms and expressions used in this directive have the following meanings:

1.1. **Thermometer** - means the measurement instrument used for measuring the temperature.

2. Definitions used in this Administrative Instruction are given in Annex A.1.

Article 4
Description of Instrument

1. The main characteristics of liquid in glass thermometers:

1.1. Liquid in glass thermometers consists of the bulb, stem, thermometric liquid and inert gas on the column where the liquid is placed. These and other details are given in the figure below for both types of thermometers: (a) the solid stem and (b) with internal scaling.

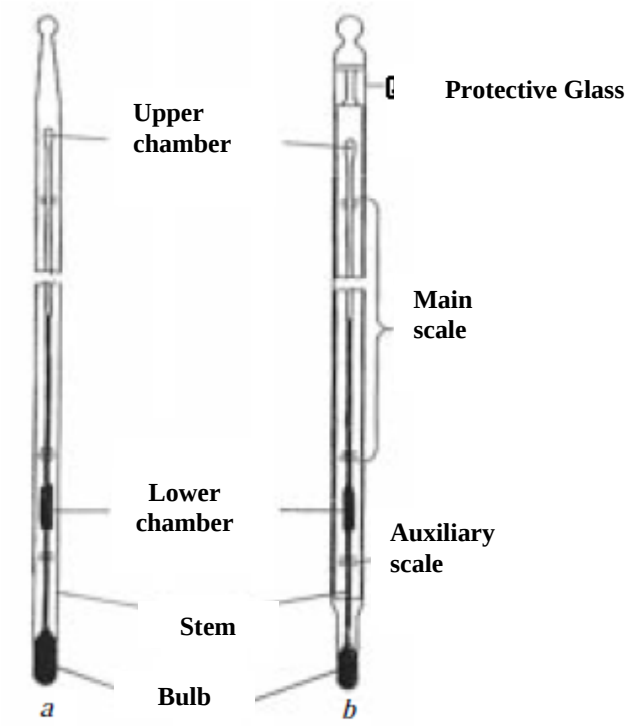

Fig. 1. The main characteristics of the liquid in glass thermometers: a) thermometers with solid stem, b) thermometers of internal scaling.

1.2. Thermometer can have one or two expansions along the capillary tube. The first expansion is located in the upper part. Its purpose is to reduce the pressure in gas filled thermometers, and provide room for thermometric liquid when the thermometer is exposed to temperatures higher than its working temperature;
1.3. The other expansion is located at the bottom part of the capillary tube, or between the main and the auxiliary part. Its purpose is to reduce the length of capillary tube. The position of this expansion along the scale should be so that the thermometer can work properly;

1.4. If the thermometer does not have expansion chambers then a piece of tube capillary of uniform transverse section located between the upper edge of the main scale and upper edge of the thermometer can serve the same purpose.

2. Types of liquid in glass thermometers:

2.1. Thermometer with solid stem consists of a tube, capillary tube with a thick wall at the end of which is fusionned the bulb and the tip of which is enclosed with the fusion. Scale is printed on the surface with a convenient method to create permanent scale;
2.2. Thermometer with internal scale consists of a small tube with the capillary tube attached to the scale stem in a fixed position. At the end of the tube is fusionned the bulb and the tip is closed with fusion. Scale stem and capillary tube are closed with a protective wrapping of glass. A wrapping of metal, or other suitable material, is attached to the upper edge or can be left also the wrapping of glass up to the end of the thermometer.

3. Vertical immersion of liquid in glass thermometers:

3.1. Full immersion thermometer is designed so as to indicate temperature correctly when the entire thermometer is exposed to temperature to be measured. This requires that the thermometer plunge into a clear liquid (bath) so then can clearly be read the measured temperature. Thermometer reading can be affected by hydrostatic pressure on the thermometer bulb which depends on the fluid in which the thermometer is immersed and the depth of immersion. Therefore, these parameters should be considered when measuring the temperature and reading the thermometer;
3.2. Partial immersion thermometer is designed to show the temperature accurately when the thermometer bulb and a specified part of the tube is exposed to the temperature to be measured. Part of the thermometer, which is not immersed, is exposed to a medium different from that for which it is measured. For high accuracy measurements, the temperature of the secondary medium should be specified. Partial immersion thermometers must have carved a line which shows to what depths can dive or any other physical indication for the allowed depth of immersion;

3.3 Total immersion thermometer is designed to show the temperature accurately when the thermometer bulb and the stem containing thermometric liquid is exposed to the temperature to be measured. It is necessary that the thermometric liquid meniscus in the thermometer stem be above the medium level (usually, one or two scale divisions) for which is measured so that the reading is done properly. The error can occur when thermometric liquid is above the emergent stem and at a temperature other than the medium for which is measured. Such errors can be compensated by applying the correction of emergent stem.

Article 5
Metrological Requirements

1. Thermometer scale is given in degree Celsius (° C). Thermometer should be traceable with national and international standard thermometers and in conformity with the International Temperature Scale of 1990 (ITS-90 (*International Temperature Scale - 1990*).

2. Notwithstanding the type of thermometer, each one should have defined accuracy class based on the maximum permissible error.

The following classes of accuracy should be applied:

Accuracy classes	Maximum Permissible Error (MPE) (ºC)
A	±0.1
B	±0.2
C	±0.5
D	±1.0
E	±2.0
F	±5.0

3. The manufacturer shall specify the temperature limits on whom is applied the defined accuracy class. Defined measuring limits shall be defined on the basis of terminal values (minimum and maximum) of scale and shall include also the expanded value which contains the accuracy class of the thermometer. According to experiments, the maximum achievable errors for certain range of temperature for several thermometric liquids that are used at liquid in glass thermometers are given in Tables 1 and 2 in Annex B.

4. Temperature scale for a thermometer with certain accuracy class must be in scale interval equal to the absolute value of the maximum permissible error. Smaller scale intervals may be allowed when within a centimeter there are not more than 14 divisions present (scale intervals).

5. The maximum permissible error for the auxiliary scale, if included, shall be the same as the main thermometer scale.

Article 6
Technical Requirements

1. Thermometric liquid used in a thermometer should be adequate for the certain range (interval) of temperature. Mercury can be used for the interval -38 ° C to +500 ° C, while for temperatures lower than -38 ° C can be used any organic liquid. Organic liquid may also include any color to facilitate reading of the thermometer if that color is not sensitive to light and does not stain the thermometer. After the organic liquid binds to the surface

(walls) of capillary tube, an adequate time is needed to filtrate liquid, especially when used at low temperatures.

2. A dry inert gas, like nitrogen, shall be inserted in the capillary tube over the column where mercury is located, to prevent possible evaporation or oxidation of mercury when the thermometer is exposed to high temperatures.

3. Capillary tube should not have visible irregularities of dimensions or contain any external material, such as tiny bits of glass.

4. Space between the scale values should be uniform for mercury thermometers or any other liquid with constant coefficient expansion, or should depend on the length of the scale so as to fit nonlinear coefficient of the liquid. Scale lines that define the intervals should be clear, straight, uniform in length and width, and indelible. Thermometers with solid stem must be equipped with a white or yellow band – not transparent in order to have a clearer view of the capillary tube and to facilitate the reading of the thermometer.

5. Values and sequences of temperature printed on the scale must be clearly legible. Internal scale thermometers should contain an indication that verifies the correct position of the scale band regarding the capillary tube. For a capillary tube having transverse prismatic cutting, no barriers should exist when looking at the column of liquid throughout its length from a fixed position.

6. Scale should be placed on the thermometer so that it complies with the following criteria which determine the minimum and maximum values of the length of capillary tube where is located the scale:

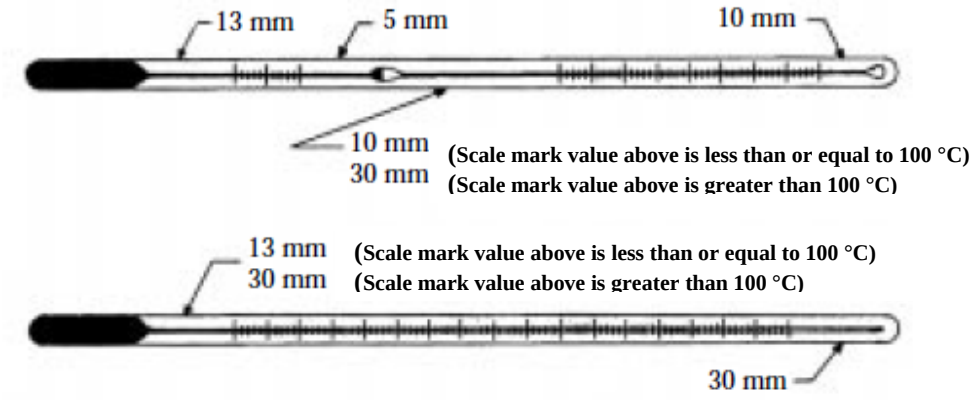

Fig. 1. Thermometer scale (minimum values)

6.1. A length of 13 mm between the bulb and the lowest value in scale, when the upper value is smaller or equal to 100 º C, and a length of 30 mm when it is greater than 100 º C;
6.2. A length of 5 mm between the lower chamber and auxiliary scale, when the lower chamber is present. This does not apply to the upper chamber;

6.3. A length of 10 mm between the lower chamber and the main scale when the upper value is less than or equal to 100 º C, and a length of 30 mm when it is greater than 100 º C;
6.4. A length of 10 mm above the maximum value in scale when the upper chamber is present, and a length of 30 mm when there is no upper chamber .

7. When the auxiliary scale is present, it must have a minimum of 10 divisions (scale), 5 above and 5 under the reference point.

8. The bulb of the thermometer should not contain gas. If gas is present, it should be removed (see Annex D).

9. The liquid in the thermometer should be uniform (unified, without spaces). If it happens to have spaces then it should be possible to do reunification, (method given Annex D).

10. Markings belonging to the scale must be indelible, and lines should be uniform and not wider than one fifth of the space between the two scale intervals. Markings can be applied by making engravings and then filling with pigment or color and drying.

11. The bulb and thermometer stem shall be manufactured from glass destined for the range of measurement temperatures of thermometers, and for the stability required for reading thermometer. The glass should stabilized with preliminary heat, so that it can afford – stand temperatures expected for measurements and mechanical pressure or hits. It shall not contain defects that would damage its reading. The bulb should not have a diameter greater than the pillar, except in special cases.

12. Each thermometer should contain symbol º C near the scale, trademark fo the manufacturer, serial number and class of accuracy. At the partial immersion thermometers, immersion depth should be specified with a line or any other physical indication. Depth of immersion also must be labeled on the thermometer. For thermometers with accuracy class A and B, the manufacturer should specify the reference temperature of the emergent stem for partial immersion thermometers.

Article 7
Practical Guidelines

1. When selecting thermometers for specific application, the limits of temperature and maximum permissible error required for measurement shall be determined. In particular, environmental conditions in which the thermometer is used must be considered.

2. If the thermometer will be used for partial immersion, it must be determined whether emergent stem temperature will be close to the value of the temperature specified for its use. Otherwise, appropriate corrections should be calculated and applied (Article 4 paragraph 3 sub-paragraphs 3.2.)

3. If the dimensions of the thermometer must comply with any particular apparatus or devices, appropriate length and diameter must be selected accordingly, whether it is required partial immersion or full immersion thermometer.

4. Organic thermometric liquids are highly volatile and have low surface pressure, therefore the distillation of organic liquid and separation of liquid column may occur. Special attention should be made for storage, preparation and use of such thermometers.

Article 8
Metrological Supervision

1. Type assessment:

1.1. The manufacturer shall submit for assessment to competent state bodies, a sample of the thermometer type, along with adequate complete instructions on certain thermometer. The testing data may indicate that the certain type of thermometer meets performance requirements under this Administrative Instruction;
1.2. Relevant state bodies shall make visual inspection and performance testing or can recognize data from the manufacturers' testing which can help to determine whether certain thermometer meets given requirements pursuant to this administrative instruction. Testing of the performance of the instrument shall be done in laboratory with environment temperature within the limits of 23 º C ± 3 º C and temperature stability of ± 1 º C during the testing period. General testing procedures of thermometers, including technical and metrological requirements are given in Annex C;

1.3. Visual inspection includes the following procedures:

1.3.1. Capillary tube with uniform diameter and free of external materials (Article 6. paragraph 3 and Annex C, point C. 1.1.)
1.3.2. Spaces between scale intervals is uniform or variable depending on the coefficient of expansion of thermometric liquid (Article 6 paragraph 4 and Annex C, point C. 1.2.)
1.3.3. Clear, straight and uniform scale markings (Article 6 paragraph 4 and Annex C, point C. 1.3.)
1.3.4. Values of the temperature scale with proper order and placement;
1.3.5. Exact position of the scale values (Article 6 paragraph 5 of Annex C, point C. 1.5.)
1.3.6. Bulb of the thermometer does not contain gas (Article 6, paragraph 8, see Annex D, point D.2. and Annex C, point C. 1.6.)
1.3.7. Liquid completely unified (unified) within the capillary tube (Article 6, paragraph 9, Annex C, and point C. 1.7.)
1.3.8. Labeling (Article 6 paragraph 12.).

1.4. Instrument performance testing includes the following procedures:

1.4.1. Stability of the scale markings (Article 6, paragraph 10, Annex C, point C. 2.)
1.4.2. Stability of the bulb of thermometer (Article 6, paragraph 11, Annex C, point C. 3.)
1.4.3. Errors of the thermometer scale (Article 5, paragraph 2, Annex C, point C. 4.)
1.4.4. Auxiliary scale or reference points errors, if included (Article 5, paragraph 5, Annex C, point C. 4.5.).

1.5. Report on visual inspection and performance testing conducted during the assessment of the type shall contain at least information specified in the Format of the Report in Annex D. Special Format can be developed depending on the relevant state bodies for state use. Manufacturers should be offered with specific comments on any test failure.

2. Initial and regular verification:

2.1. Visual inspection and instrument performance tests specified in Article 8 paragraph 1 subparagraph 1.3.dhe 1.4. except the point 1.4.1 in Article 8 subparagraph 1.4. shall be performed during the initial verification or subsequent verification;

2.2. The period of validity of initial verification or subsequent verification is regulated by special bylaws.

3. For thermometers that successfully pass the procedure of type assessment and initial and subsequent verification, certificates can be issued.

4. Liquid in glass thermometers can be used as secondary thermometers or as the reference standard after they are calibrated. The list of measurement uncertainties that can be achieved for thermometers calibrated on specific temperature limits is given in Annex F (information).

Article 9
Transitional Provisions

Integral parts of this Administrative Instruction are: Annex A, B, C, D, E and Annex F

.**Article 10**
Entry into Force

This Administrative Instruction shall enter into force on the day of signing by the Minister of Trade and Industry.

Prishtina, 20.04.2011 **Mimoza KUSARI-LILA**

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Minister of MTI

Annex A

A. 1. Terminology

A. 1.1. Stem

The glass tube containing the capillary tube through which thermometric liquid moves during the change of temperature.

A.1.2. Capillary Tube

Reservoir where is located the liquid.

A.1.3. Lower Chamber

Supplement to the capillary tube located under the main part of the scale or between the main and the auxiliary part and serves to reduce the length of the thermometer or to prevent contraction of the liquid in the capillary tube.

A.1.4. Upper Chamber

Supplement to the capillary tube located in the upper part of the capillary tube which serves to protect the thermometer from the swelling of liquid or gas pressure when the thermometer is exposed to high temperatures.

A.1.5. Main Scale

Thermometer scale with the respective unit for the band (limits) of work temperature of the thermometer.

A.1.6. Auxiliary Scale

Optional scale (auxiliary) in the upper or lower edge of the thermometer, containing a reference point, usually the ice point 0 º C.

A.1.7. Band of the work temperature (measurement)

Set of temperature values, for which the thermometer error is thought to be within specified limits.

A.1.8. Maximum Permissible Error

Maximum values of error of the instrument, specified by the regulations for a certain liquid in glass thermometer.

A.1.9. Accuracy Class

Class of liquid in glass thermometers that meets some specific requirements for keeping errors within certain limits

Annex B
Maximum permissible errors for liquid in glass thermometers

1. Maximum achievable errors for thermometers with liquid in glass are given in Table 1 and 2, where are listed the limits of the temperature measurement and thermometric liquids for which experience has shown what accuracy class are currently achievable.

Explanation: The values shown are valid when they are determined in laboratory conditions.

Table 1: Maximum achievable errors for full immersion thermometers

Accuracy Class (MPE)[a]	Temperature Limits in ºC							
	– 200 to – 38[b]	– 38 to 0	0 to + 50	+ 50 to + 100	+ 100 to + 200	+ 200 to + 300	+ 300 to + 360	+ 360 to + 500
A (± 0.1)		M[c]	M	M				
B (± 0.2)		M	M	M	M			
C (± 0.5)		M	M	M	M	M		
D (± 1.0)		M	M	M	M	M		
E (± 2.0)	O[d]	M/O	M/O	M/O	M/O	M	M	
F (± 5.0)	O	M/O	M/O	M/O	M/O	M	M	M

a MPE means Maximum Permissible Error in ºC
b - 38 ºC is the freezing point of mercy
c M presents the thermometer with mercury
d O presents the thermometer with organic Liquid

Table 2: Maximum achievable errors for partial immersion thermometers

Accuracy Class (MPE)[a]	Temperature Limits in ºC							
	– 200 to – 38[b]	– 38 to 0	0 to + 50	+ 50 to + 100	+ 100 to + 200	+ 200 to + 300	+ 300 to + 360	+ 360 to + 500
A (± 0.1)		M[c]	M	M				
B (± 0.2)		M	M	M	M			
C (± 0.5)		M	M	M	M	M		
D (± 1.0)		M	M	M	M	M		
E (± 2.0)	O[d]	M/O	M/O	M/O	M/O	M	M	
F (± 5.0)	O	M/O	M/O	M/O	M/O	M	M	M

a MPE means Maximum Permissible Error in ºC
b - 38 ºC is the freezing point of mercy
c M presents the thermometer with mercury
d O presents the thermometer with organic Liquid

Annex C
Test Procedures

C. 1. Visual Inspection

C. 1.1. Examine the entire capillary tube of thermometer to determine whether it is uniform and without any noticeable deformation or irregularity and free from any external material.

Note: Materials such as tiny glass particles, which can be inserted in the capillary tube during production can move within the capillary tube and thereby inhibit liquid or put gas inside and this way causing errors when reading the thermometer. This inspection can be performed with the help of a low force microscope or magnifying lenses.

C. 1.2. By using a device to measure length, it is ensured that the lines of the thermometer scale have uniform space between them without significant differences from the end of one line to another. This applies to thermometers with thermometric liquids with constant coefficient of expansion over the temperature values in scale. Due to non-uniform expansion of organic liquids, organic liquids thermometers may show more pronounced changes in the scale spaces than mercury thermometers.

C. 1.3. By using a device for measuring length, the lines of the thermometer scale are examined. These lines should be clear with sharp edges, straight, uniform and with adequate length. They must not be wider than one fifth of the space between the two scales (i.e. the distance between the centers of two scale lines). For a thermometer with internal scale it is controlled the correct placement of scale band. For a thermometer with transverse cutting prismatic of the capillary tube it is controlled whether there is any obstacle that would prevent clear view of the thermometric liquid the entire length of the capillary tube from a fixed position.

C. 1.4. Examination of the numbers and the order of them in thermometer scale. Numbers must be clear and legible and in proper order and must correspond precisely to the scale line. If auxiliary scale is involved, it is verified its conformity with Article 6, paragraph 7.

C. 1.5. By using a device for measuring length, it is controlled minimum distance related to specified scale in Article 6, paragraph 6 within the limits of ± 1 mm. The distance should not be smaller but may be greater than that specified.

C. 1.6. Thermometer bulb is examined for the presence of gas. If gas is present, it is eliminated by the method given in Annex D, section D. 2. or any similar method.

C. 1.7. It is determined whether the thermometric liquid is continual. If not, its reunification is conducted by the method given in Annex D, section D. 3. or any similar method.

C. 2. Sustainability of the scale markings

C. 2.1. One part of the thermometer scale is exposed to temperature 260 º C, or the maximum thermometer temperature, if it is less than 260 º C, for about 3 hours. After this time the thermometer is removed and left to cool down and it is compared the heated part of scale with the other part.

C. 2.2. The thermometer will pass this test if pigment or color is not released, burned or faded.

C. 3. Stability of the bulb of thermometer

C. 3.1. Complete bulb of thermometer is immersed into a bath or oven with temperature equivalent to the maximum temperature specified in its work band. Once the thermometer reaches thermal equilibrium, as verified by observing changes in the level of thermometric liquid, thermometer is removed from the bath or oven and is left to cool down slowly in air with temperature 20 º C above the environment temperature or at temperatures 50 º C, whichever is smaller. Thermometer then is placed in a reference bath, same as ice bath, and it is recorded its temperature shown within an hour.

C. 3.2 The bulb of the thermometer is placed back in the heated bath or oven (as in section C. 3.1.). After a period of 24 hours the thermometer is removed left to cool down in the same manner as described in paragraph C. 3.1. Again, the thermometer is placed in a reference bath and it is recorded it temperature.

C. 3.3. The difference between the temperatures measured at point C. 3.1. and point C. 3.2. should be within ± 70% of the maximum permissible error of the thermometer.

C. 4. Errors in the band of work temperature

C. 4.1. A reference thermometer and a bath with closing cover, with constant temperature should be used to test the liquid in glass thermometer, to determine whether its indicators are within the maximum permissible error specified in Article 5, paragraph 2. Measurements should be made at least for terminal values (minimum and maximum value) of the band of work temperature for the accuracy class specified by the manufacturer and one or more temperature values between terminal values. Measurements should also be made for a reference temperature. If the thermometer has auxiliary scale, it should be controlled (tested).

Note: Before you make this test, the thermometer should remain at room temperature for at least three days so that the bulb of the thermometer is stabilized.

C. 4.2. It is used a reference thermometer with valid calibration and measurement uncertainty in the band required for work temperature not greater than one-fourth of the absolute value of the maximum permissible error of the thermometer test.

Note: Reference thermometer can be industrial thermometer with platinum resistance calibrated with proper instrument for the measuring of resistance, digital thermometer, or better a liquid in glass thermometer.

C. 4.3. It is used in a bath with closed cover, with constant temperature, uniform and regulated throughout the medium, which has sufficient volume and depth to establish a certain number and types of thermometers to be tested. Bath temperature is regulated within the limits of ± 0:01 º C, so that the temperature changes inside the used parts of the bath to be within the limits of ± 12:05 º C.

Note: Manufacturers of baths with constant temperature should be consulted regarding the appropriate oils and salts. The following mediums should be used for the baths with temperatures range shown below:

-200 ºC to -150 ºC	liquid nitrogen
-150 ºC to - 50 ºC	methyl pentane
-50 ºC to 0 ºC	ethanol
+5 ºC to + 95 ºC	water
+95 ºC to +200 ºC	oil
+200 ºC to +500 ºC	molten salt

C. 4.4. At liquid nitrogen temperature (approximately - 200 º C) it is controlled the error by immersing the reference thermometer and the thermometer to be tested in a Devar baloon which contains liquid nitrogen. Within approximately two or three minutes after the reference thermometer shows stable temperature of the bath, the values of two thermometers are read simultaneously. The difference between the readings of two thermometers should not exceed the value of the maximum permissible error of the thermometer tested.

C. 4.5. In the range of temperature from -110 º C to +500 º C, the errors are controlled using a bath with the closed cover with constant temperature as described in point C. 4.3. Thermometer to be tested is placed in the bath together with the reference thermometer, it is immersed so the meniscus is no more than 10 mm above the surface of the liquid. If the thermometer is with partial immersion, then it is immersed up to the line which specifies the depth of immersion. In subsequent points of higher temperatures, total immersion thermometers are immersed deeper into the liquid but always the meniscus remaining 10 mm above the surface of the liquid, whereas partial immersion thermometers remain in the starting position throughout testing. During the testing of the thermometers with organic liquid, a certain time is needed so that the organic liquid streams into capillary tube, for temperatures below the room one. Within approximately two or three minutes after the reference thermometer shows stable bath temperature, values of the two thermometers are read simultaneously. The difference between the readings of two thermometers should not exceed the value of the maximum permissible error of the thermometer tested.

C. 4.6. In point of ice (0 º C), the error is controlled by immersing the thermometer to be tested in an ice bath. The ice bath is prepared by adding distilled water ice particles. Once the ice melts, it may be necessary to remove an amount of water and add ice particles.

Total immersion thermometer, is placed in the bath so that meniscus to have two scale divisions above the surface of ice or it is quickly removed from the bath for reading; thermometer with partial immersion, is immersed up to the line which specifies the depth of immersion. When the thermometer is placed in the appropriate depth, surrounded by ice, it is waited 1 to 2 minutes for the thermometer to reach equilibrium. Before reading, the thermometer is shaken (hit) easy, to eliminate the possibility of the deadlock of mercury in the column. The difference between the tested thermometer indicator and point 0 º C should be within the maximum permissible error of the thermometer tested.

Note: This test also applies to control auxiliary scale, if included. Ice should be prepared by using laboratory water which can be distilled, de-ionized or filtered.

Annex D
Methods for eliminating defects in Thermometric liquid
(Informatve)

D. 1. This Annex provides examples of methods by which defects in the thermometric liquids in the bulb and capillary tube of thermometer can be eliminated, which means, the gas is removed if it is present and reunification of separated liquid is made. Other equivalent methods can also be effective.

D. 2. With visual inspection is examined the thermometer bulb to determine the presence of any gas which would appear as a circle the internal surface of the glass of bulb. If gas is present, it is removed with the following method or any other method equivalent.

Note: This method applies only to mercury thermometers. This inspection can be done with the help of a low force microscope or magnifying lenses.

D. 2.1. It is immersed only the bottom half of the bulb in the dust of carbon dioxide (dry ice) or ice-dust mixture with alcohol.

Note: The bulb should not remain immersed for a long period of time because mercury can freeze then break off the bulb of thermometer, if the bottom part of the mercury in the bulb is melted before the upper part.

D. 2.2. When the mercury reaches the bottom of the cone, which makes the unification of the bulb with the stem of the thermometer, thermometer is removed from dry ice. Thermometer is held in inverted position, and then it is hit easily by hand to insert a large gas bubble in the thermometer bulb. Thermometer is hit and rotated by hand, so that bubbles of gas to be in contact with all the internal surface of the bulb, removing other small bubbles which are present.

D. 2.3. Thermometer is microscopically examined again to ensure that all small gas bubbles are removed. When only the large bubble of gas is present and that on top of the bulb, the bottom half of the bulb is placed again on dry ice and it is allowed to go down to the cone or top of the bulb of the thermometer. Thermometer is removed form the dry ice. While in a vertical position, the thermometer is shook in a circular manner or the thermometer bulb is easily hit into a soft surface like rubber.
One of these two methods will force large bubble of gas to be removed and the reunification of the mercury column is made.

D. 3. The following method or any similar method is used to make the reunification of the divided thermometric liquid.

D. 3.1. For a thermometer filled with mercury, it is used the dry ice so that the mercury thermometer descends to the bulb of thermometer or below. Thermometer is removed from dry ice and is hit lightly with a soft object, such as rubber, to extract mercury from the thermometer bulb walls or cone. Thermometer is left at room temperature for a time and stem of mercury will be reunified.

D. 3.2. For a thermometer filled with mercury containing expansion chamber and division in the upper part of the column of liquid, the bulb of the thermometer is heated to allow the separate part and upper part of the mercury column to be reunited in expansion chamber , causing the space in the middle of the separated part to becomes very thin when the mercury reaches in the largest diameter of the expansion chamber. Thermometer is softly hit by hand to extract mercury from the chamber walls. Then it is hit softly with a soft surface to force mercury to descend down to the expansion chamber from where it can rise to the top of the column of mercury when the thermometer is heated again.

Note: When using this method (which is not applicable if it is required that the thermometer to be heated in temperature above 260 ºC), thermometer should not be heated with concentrated heat source, such as fire. Preferably, the thermometer is heated with a liquid that has the point of boiling and evaporation higher than the maximum scale of thermometer. If the bulb of the thermometer is heated, then the thermometer must be kept for a period of at least 72 hours before they performance tests are conducted.

D. 3.3. For a thermometer filled with organic liquid, reunification of separated liquid is conducted either (a) by forcing the separated part and the upper part of the organic liquid to go down into the expansion chamber as described in section D.3.2, or (b) by distributing separate liquid with soft hits of the thermometer by hand and then the thermometer is held in a vertical position causing the separated liquid to flow down the capillary tube, and thus it is reunified with the main column. Thermometer with organic liquid should be heated before use since organic pure liquid can be condensed into expansion chamber .

D. 3.4. Centrifugal force is used to reunify the separated liquid by placing the thermometer in the centrifuge with the bulb directed outside (high).

Annex E
Format of Test Report

This format of the test report presents, in standard mode, the results of various tests and examinations, which will undergo a type of liquid in glass thermometer when taking into consideration the type approval. These tests are given in Annex C of this Administrative Instruction.
Using this test report format is informative, and can be changed depending on the relevant state bodies. However, it is recommended that such a format to be used by metrological services or laboratories of calibration and type approval of liquid in glass thermometers.

The format of Test Report should contain the following data:

Report number: .....
Year:
.....

1. Name and address of testing laboratory
.....
.....
.....
.....

2. Location where the test is conducted, if different from item 1
.....
.....
.....
.....

3. Name and address of manufacturer
.....
.....
.....
.....

4. Name and address of the applicant, if different from that of manufacturers
.....
.....
.....
.....

5. **Identification of the type tested**

● Trade Mark.....

● Type Number.....
● Serial Number.....

● Class of accuracy.....

● Interval scale.....

● Range of temperature measurement.....

● Type of immersion…….....

6. Summary Report of Visual Inspection

6.1. Capillary tube with uniform diameter and free from any external material:

passed □ not passed □

Comments:
.....
.....
.....
.....

6.2. Uniform width of the scale space (or adapted by the coefficient of expansion of thermometric liquid):

passed □ not passed □

Comments:
.....
.....
.....
.....

6.3. Clear, straight and uniform scale lines:

passed □ not passed □

Comments:
.....
.....
.....
.....

6.4. Temperature values in scale are in exact position and order:

passed □ not passed □

Comments:
.....
.....

.....
.....

6.5. Scale set in the thermometer according to the specifications of Article 6, paragraph 6 (and paragraph 7 if the auxiliary scale is present):

passed □ not passed □

Comments:
.....
.....
.....
.....

6.6. Gas in the bulb of thermometer: yes no
Gas successfully removed: yes no

Comments:
.....
.....
.....
.....

6.7. Liquid contains spaces: yes no
Liquid successfully reunified: yes no

Comments:
.....
.....
.....
.....

6.8. Labeling of thermometer

passed □ not passed □

Comments:
.....
.....
.....
.....

7. Summary Report of the thermometer performance test

7.1. Sustainability of the scale markings

passed □ not passed □

Comments:
.....
.....

.....
.....

7.2. Testing of the stability of the bulb of thermometer

● **Reference Temperature:** …….
● **Thermometer temperature indication during testing:** ….....
● **Difference:** .....

passed □ not passed □

Comments:
.....
.....
.....
.....

7.3. Thermometer errors:

● Environment temperature in the testing laboratory:
before testing: .....
after testing: ……....

● Reference thermometer:
type: .....
uncertainty: .....
date of last calibration: .....
accuracy class specified by the manufacturer: .....
range of measurement temperature: .....

● For partial immersion thermometer tested:
reference temperature of emergent stem:….....
measured temperature of emergent stem: .....……...
correction: .....

Note: For partial immersion thermometers of accuracy class A and B, correction of temperature of emergent stem may be required. In such cases, the differences shall be given in the table below to record reference temperature of the emergent stem, measured temperature of the emergent stem and correction of value of the measured temperature.

Temperature indication in ºC		
Reference thermometer	**Tested thermometer**	**Difference (error)**

passed □ not passed □

Comments:
.....
.....
.....
.....

7.4. Auxiliary scale errors, if included, and / or reference point:

● Reference Temperature: .....
● Temperature indication of tested thermometer: .....
● Difference: .....

passed □ not passed □

Comments:
.....
.....
.....
.....

8. A brief statement of conclusions if the tested thermometer meets the requirements of this Administrative Instruction:

9. Person (s) responsible for testing the thermometer

Name and Signature: .....
Date: .....

Annex F
Achievable measurement uncertainties for calibrated thermometers
(Informative)

F. 1. Liquid in glass thermometers may be used as secondary thermometers or standard reference thermometers.

F. 2. Table 3 contains a list of expanded measurement uncertainties (k = 2) in the calibration of liquid in glass thermometers, with total immersion.

F. 3. Table 4 contains a list of expanded measurement uncertainty (k = 2) in the calibration of liquid in glass thermometers, with partial immersion.

Table 3

Accuracy Class (MPE)[a]	Temperature range in ºC within specified limits								
	– 200 to + 50	– 100 to + 50	– 38[b] to + 100	– 10 to + 50	– 10 to + 100	– 10 to + 200	– 10 to + 300	– 10 to + 400	– 10 to + 500
A (± 0.1)			± 0.02	± 0.02	± 0.02				
B (± 0.2)			± 0.03	± 0.03	± 0.03	± 0.06			
C (± 0.5)			± 0.05	± 0.05	± 0.05	± 0.1	± 0.1		
D (± 1.0)			± 0.1	± 0.1	± 0.1	± 0.2	± 0.2		
E (± 2.0)		± 1.5[c]	± 0.2 ± 1.5[c]	± 0.2 ± 1.5[c]	± 0.2 ± 1.5[c]	± 0.5 ± 2.0[c]	± 0.5	± 1.0	
F (± 5.0)	± 3.0[c]	± 3.0[c]	± 0.5 ± 3.0[c]	± 0.5 ± 3.0[c]	± 0.5 ± 3.0[c]	± 1.0 ± 3.0[c]	± 1.0	± 2.0	± 3.0

a MPE means the Maximum Permissible Error in ºC
b - 38.8 º C is the freezing point of mercury
c shows a thermometer with organic liquid, otherwise the values of measurement uncertainty are applied for thermometers with mercury

Table 4

Accuracy Class (MPE)[a]	Temperature range in ºC within specified limits								
	– 200 to + 50	– 100 to + 50	– 38[b] to + 100	– 10 to + 50	– 10 to + 100	– 10 to + 200	– 10 to + 300	– 10 to + 400	– 10 to + 500
A (± 0.1)									
B (± 0.2)				± 0.05	± 0.05				
C (± 0.5)			± 0.1	± 0.1	± 0.1	± 0.2			
D (± 1.0)			± 0.2	± 0.2	± 0.2	± 0.3	± 0.5		
E (± 2.0)			± 0.5	± 0.5	± 0.5	± 1.0	± 1.0	± 2.0	
F (± 5.0)	± 4.0[c]	± 4.0[c]	± 1.0 ± 4.0[c]	± 1.0 ± 4.0[c]	± 1.0 ± 4.0[c]	± 2.0 ± 4.0[c]	± 2.0	± 3.0	± 4.0

a MPE means the Maximum Permissible Error in ºC
b - 38.8 º C is the freezing point of mercury
c shows a thermometer with organic liquid, otherwise the values of measurement uncertainty are applied for thermometers with mercury