UDC 528.4

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ABOUT STANDARDIZATION OF GEODETIC TERMINOLOGY

Summary

In many scientific sources: scientific papers, presentations at conferences, dictionaries, textbooks, manuals there are often used, in our opinion, inaccurate, sometimes russified expressions. In addition, some scientific names and terms are interpreted by different authors in different ways.

The paper discusses terminological expressions that occur most frequently in Ukrainian geodetic literature, mainly relating to theodolites and electronic total station. The interpretation of some scientific and technical terms which are used to define the basic concepts related to the theodolites and electronic total station is specified.

We propose our own view on the writing of some commonly used geodetic terms in the Ukrainian language as well as suggestions for making some corrections, both to the scientific names themselves and to their interpretation, since we consider that the Ukrainian geodesic terminology system is gradually being improved, acquires national features, clarification and transparent motivation.

It is specified when it is possible to use such concepts as a sighting axis and a line of sight; collimation and collimation error; zero position and reading of zero position, etc. It is correct to use such a concept as a constant of a set or an instrument correction of a set total station reflector; the influence of external conditions or the influence of the external environment on the measurement results; magnification of telescope of times (krat) or (raziv). It is given an explanation about the effect of the inclination of horizontal axis of angle measurement instrument on the results of measuring horizontal angles and what cause the inclination of the axis.

Regression formula for assessment of accuracy of measuring lines with electronic total stations was simplified, as well as the approach for determination of experimental additive and multiplicative mean square error of measurement of distance was changed.

Proposed, in our opinion, correct Ukrainian-language writing of some terms and their interpretation could be usefull when writing scientific papers, methodological materials, manuals and State Standards. In addition, the terms translated into English, can help students and postgraduates when studying English.

Keywords: geodetic terms, Ukrainian language, accuracy of denotation of concepts.

Specifying the problem

In many scientific sources: scientific papers, presentations at conferences, dictionaries, textbooks, manuals there are often used, in our opinion, inaccurate, sometimes russified expressions.

We offer our own view on writing some commonly used geodetic terms in Ukrainian.

Presentation of the main material

As it is known, professional Ukrainian terminology is slowly being improved, gets rid of Russian-speaking tricks, tries to restore (to reproduce) its own national correspondences, which would precisely, accurately and clearly indicate one or another scientific and technical concept.

Today, unfortunately, the state of geodetic terminology is not quite satisfactory, since in Ukrainian textbooks, manuals, scientific papers the same objects, phenomena, processes are denoted differently.

As you know, in Ukraine there is a State Standard SSTU-2399-94 for terms and definitions in geodesy. This is one of the first official documents, an attempt to systematize and legalize Ukrainian terms in geodesy. However, this document is not perfect.

In this paper we will try to give correct version for known and used terms, which, in our opinion, more accurately indicate their concepts in geodesy.

As the paper underline some peculiarities of Ukrainian language for geodetic terms, please note, that in English version of the paper it cannot be described so clear.

It is used	It is proposed
Problem statement	**Specifying the problem**
Sphere of application … *Sphere – a ball shaped object;* *an area of of physical or spiritual life, activity of persons or society;*	Branch of application… *Branch – a certain area of production, science, etc..*
Optical and electronic levels	Optical-mechanical and digital levels
Digital levels are also optical. Once the devices were divided into mechanical and optical, usually releting to the material of circle manufacturing. if the circle is metallic - mechanical, if glass, - optical. in order to distinguish digital devices from optical ones, we suggest to use the word optical-mechanical instead optical, and word digital levels for electronic levels, because abroad levels are called - digital.	
This can be used for assessment of compliance with its requirements	This can be applied for assessment of compliance with its requirements
It can be used in the production, assessment of compliance and testing (povirka) of geodetic instruments *Testing (povirka) 1. Roll call of persons with purpose to check the attendees 2. (obsolete) Controlling, checking someone for the purpose of identifying knowledge.*	It can be used in the production, assessment of compliance and testing(pereviryannya) of geodetic instruments *To test (pereviryaty)* *To find out the correctness, accuracy of anything.*
The concept of testing involves such concepts as adjustment and calibration of instruments. In our opinion, the notion of adjustment is better to apply to fix geometric conditions, and calibration for electronic equipment of instruments. For example, the calibration of the frequency of l light range finder . **Adjustment** of measuring instrument is a set of operations in order to prove the errors of measuring instrument to the values that meet the technical requirements. **Calibration** is a set of operations by which at the given conditions in the first stage a correlation is established between the values provided by the standards with the measurement uncertainties inherent to them and the corresponding reading with the measurement uncertainties associated with them, and in the second stage this information is used for establishment of ratio to get the measurement result from the reading.	
It can be used for control.	This can be used for monitoring .
During their testing (povirka) in operation	For their testing (pereviryannya) (for control)
The technical characteristics controlled during their testing (povirka) in operation are determined by the appropriate method of testing (povirka)	The technical characteristics that are controlled during the testing (pereviryannya) are determined by the appropriate method of testing (pereviryannya)
For further analysis will add some definition of terms. **Sighting axis.** A line that connects the back focal point of the lens and the center of the grid of strokes. But how do you interpret the sighting axis in NZK, Ni 007 levels or digital levels, or in the South NTS352R electronic total stations? Therefore we propose to use the concepts of the line of sight. **Line of sight**. Line that connects the back focal point of the lens and the projection of the center of the grid of strokes in the space of objects. **Vertical axis of an instrument.** Axis of rotation of the alidade of horizontal circle in horizontal plane (for angular instruments). **Vertical axis of an instrument.** Axis of rotation of the instrument in a horizontal plane (for levels, instruments of vertical design, etc.). **Horizontal axis of an instrument.** Axis of rotation of the telescope in vertical plane (for angular instruments). **Horizontal axis of an instrument.** Axis of rotation of the telescope in vertical plane (for levels). T**he plane of angular circle.** A plane that includes a limb of an angular circle. **Limb**. Working dial of a geodetic instrument in the form of a circle scale. **Main vertical circle.** The position of the circle for which its readings correspond to the real angles of the inclination (zenith distances) of telescope. **Reading of angular instrument** is the distance from the zero line of the scale to the orthogonal projection of the plane containing the line of sight on this scale.	

Reading of scale is he distance from the zero line of the scale to the zero of reading device that touches upon it or projects on it.

Cross hair (*reticule)*	**Cross line (*reticule)***
Once the spider threads were pasted onto a flat-parallel plate, so this plate was called a cross hair.	Now, on the flat-parallel plate, the lines are engraved.

A cross line can be in the form of a point, straight parallel lines, intersecting straight lines, straight lines in the form of a wedge, strings in the form of a circle or concentric circles.

Collimation error The deviation of telescope axis and perpendicular to the axis of rotation.	**Collimation** The angle between line of sight and its position which is perpendicular to the horizontal axis **Collimation error** The angle in projection on horizontal plane between line of sight and the plane perpendicular to the horizontal axis of instrument

Collimation itself, while measuring angles, for unchanging other conditions, will not change, but it is important for us to know its influence on the measurement of horizontal angles. Horizontal angles are measured in the projection on horizontal plane. During the bending of the telescope, the projection of collimation angle will change its value, and for the plumb position of the telescope, this projection will be reflected by two points. We determine the collimation in the projection on a horizontal plane. Therefore, the concept of collimation error relates to the horizontal position of the line of sight.3

Zero position	**Zero position**
The angle in the vertical (plumb) plane between the sighting telescope axis and the horizontal plane at zero reference of vertical circle at the left face.	Angle in plane of vertical circle between line of zeros of limb and zero position reference**.** **Reading of zero position** Reading on the plumbing, main vertical circle for horizontal line of sight

If, for the definition of what is in the literature, a plumb plane to be drawn through the horizontal axis of the instrument, then where will there be a position of zero? Therefore, this angle should be attributed to the plane of the vertical circle.

In our opinion, there should be two definitions, which are given above - the position of zero (the angle) and the reading of zero position (reading).

For instruments with level at alidade of vertical circle.

Reading of zero position – reading on the main vertical circle of projection of the horizontal line of sight, when the vertical axis of the instrument is plumb, the line of sight and the axis of barrel level at the alidade of vertical circle is horizontal.

For instruments with a compensator of readings of vertical circle.

Reading of zero position – в reading on the main vertical circle of projection of the horizontal line of sight, when the vertical axis of the instrument is plumb, and the line of sight is horizontal.

Zenith position	**Zenith position**
Deviation from 90 ° in the vertical (plumb) plane of the angle between the visual axis of the telescope and the plumb line when reading is 90 ° on vertical circle at left face.	Angle in the plane of vertical circle between line of limb zero and reading of zenith position. **Reading of zenith position** Reading on plumb main, vertical circle for plumb line of sight.

In our opinion, the vertical plane needs to be defined, because it will lead to misunderstandings, as well as to the zero position. The same applies to the reading of zenith position.

For instruments with level at alidade of vertical circle.

Reading of zenith position – reading on the main, vertical circle of projection of the plumb line of sight, when the vertical axis of the instrument is plumb, the line of sight is directed to the zenith and the axis of barrel level at the alidade of vertical circle is horizontal.

For instruments with a compensator of readings of vertical circle.

Reading of zenith position – reading on the main vertical circle of projection of the plumb line of sight when the vertical axis of the instrument is plumb, and the line of sight is directed to the zenith..

Cylindrical level *Cylinder – math.* A geometric body formed by rotating a rectangle around one of its sides. *Techn.* A part or device that has the shape of cylinder. So the inner surface is a cylinder with parallel surface. *Is it its working surface?*	**Barrel level** *Barrel.* It has form of barrel. *It is its working surface* *Spherical.* It has form of sphere. *It is its working surface*
Which serves as a compliance criterion when performing a procedure of conformity assessment or testing (povirka)	Which is a criterion for assessment of compliance or testing (pereviryannya)
Which is compared with the normalized numerical value when the assessment of conformity or testing (povirka).	Which is compared with the normalized numerical value when assessment of compliance or testing (pereviryannya).
The angle (direction) measured in one (full) set The mean of the measurements at the face left and the face right position of the theodolite or the geometry of the angle value, calculated from the specificity of the calibration of the vertical or horizontal limb and the reading of data from it. *What is the difference between set and full set?*	**The direction measured in one set** The average value of the direction measured by theodolite or total station, with a circle at left face and right face of circle, which is calculated taking into account the specificity of the vertical or horizontal circle gravity and the procedure of taking reading from it. **The angle measured in one set** The difference between the average directions, measured in one set.
The word direction (napryam, close to course) is used when the end point is located at a considerable distance. If we are talking about a line of physical motion at short distances, then – direction (napryamok). *The logic of senses tells the linguists what word is more appropriate to use in a particular situation. Therefore, the direction (napryam, close to course) will be strategic, but let's go, we move - in the direction (napryamok).*	
Distance (vidstan) *The length of the space between two objects*	**Distance (viddal)** *Distance from the Earth to the Moon, distance between straight lines, distance between cities, distance between two points, distance from point to plane, distance from point to line*
Mean square error of measurement (vymiryuvannia) …total station, which is determined by the formula *Measurement (vymiryuvannia). Action to measure something*	**Mean square error of measurement (vymir close to dimension)** …total station, which is determined by the formula *Measurement (vymiryuvannia, dimension) math. Value which is measured.*
Vertical angle measured by the standard (sample) on cross hair of instrument when the platform is tilted in the forward direction (napryamok);	Vertical angle measured by the standard (sample) on cross line of instrument when the platform is tilted in the direction (napryam) of objective or leftside;
Vertical angle measured by the standard (sample) on cross hair of instrument when titling platform in the direction (napryamok) back to forward at the same angle of titling;	Vertical angle measured by the standard (sample) on cross line of instrument when the platform is tilted in the direction (napryam) of ocular or rightside at the same angle of titling;
Eccentricity Not a coincidence (ne spivpadinnya) of the rotation axis of a certain structural part of instrument and center of reading angular device (limb) assigned to it. *The word "ne spivpadinnya" does not exist in the Ukrainian language.*	**Eccentricity** Lack of coincidence (nezbih) of axis of rotation of certain structural part of instrument and center of limb assigned to it.. *Lack of coincidence (nezbih) – spec. Violation of the symmetrical arrangement of adjacent parts, tangential surfaces, etc.*

Theoretically, when the measurements in a full set, error in the angle related to the eccentricity is eliminated.	Theoretically, when the measurements in a full set, error related to the eccentricity in the case of two side readings is eliminated.
To determine eccentricity it is necessary to distinguish it. **Eccentricity of alidade of horizontal circle**. *Lack of coincidence* of vertical axis of instrument and the center of the graduated circle (limb). **Eccentricity of horizontal circle**. *Lack of coincidence of* axis of rotation of the horizontal circle and the center of the graduated circle (limb). **Eccentricity of alidade of vertical circle**. *Lack of coincidence of* axis of rotation of alidade the center of graduated circle (limb) of vertical circle. **Eccentricity of vertical circle.** *Lack of coincidence* of horizontal axis of instrument and the center of graduated circle (limb) of vertical circle.	
Change of the non-perpendicularity of axis of telescope rotation to axis of rotation of instrument alidade when inclination of instrument telescope.	**Non-perpendicularity of the horizontal and vertical axes of instrument**
The non-perpendicularity of horizontal and vertical axes during tilting of the instrument telescope does not change. If they are non-perpendicular, then during observations of points located above and below the instrument, the reading of horizontal circle will have error caused by the non-perpendicularity of the axes. If the horizontal axis of the device is tilted, for example, the left side relative to the observer, then for the given example, when the telescope is tilted downward, the reading will increase. If the axes are perpendicular, but the vertical axis is not plumb in the vertical plane of horizontal axis, this will cause the same error as the non-perpendicularity of the axes. Not plumbing of the vertical axis may also arise due to its rotation. Therefore, for the correct determination of angle of non-perpendicularity, the errors of non-plumbing and oscillation must be eliminated.	
Systematic component (skladova) of measurements of horizontal angles with one full set, which appears when the angles are measured on points, located above and below the horizon of the instrument.	A systematic component (skladnyk) of measurements of horizontal angles in one set, which occurs when measurements at points, one of which is located above, and the second one below the horizon of the instrument.
The standard (sample) value of the angle, which can be, for example, 180°, if the standard (sample) angle are created by two auto-collimators directed one on the other.	The standard (sample) value of the angle, which can be, for example, 180°, if the standard (sample) angle are created by two auto-collimators directed one on the other and the vertical axis of instrument device is located on the line of sight of these collimators
Standardized by the manufacturer	Regulated by the manufacturer
The mean square error of distance (vidstan) measurement (vymiryuvannia) by electronic total station is calculated by the formula C $\sigma_L = a + b \cdot L \cdot 10^{-6}$ L - measured distance (viddal) (line length) defined in millimetres, which serves as a compliance criterion when the implementation of the compliance assessment procedure or testing (povirka) of the distance-measuring…	The mean square error of distance (viddal) measurement (vymir) by electronic total station is calculated by the formula $\sigma_L = (a + b \times L) мм$ L – measured distance (viddal) defined in kilometres which is compliance criterion during compliance assessment or testing (pereviryannia) of the distance-measuring…
Why is such a great formula? If *L* is put in km, then the calculations can be done mentally.	
Experimental additive component of RMS errors of distances measurements… of total stations that is determined by the formula:	**Experimental additive RMS errors** of distances measurements… of total stations that is determined by the formula:

$\tilde{a} = \gamma \cdot \sqrt{\frac{\sum_{i=1}^{n}(L_i - L_i^{ms})^2}{v}}$ where L_i - measured values of distances; L_i^{ms} - standard values of distances with length up to 100 m; $v = n$ - the number of degrees of freedom, equal to the number of measured distances up to 100 m.	$\tilde{a} = \gamma \cdot \sqrt{\frac{\sum_{i=1}^{n}(L_i - L_i^{ms})^2}{v}}$ where L_i – measured values of distances; L_i^{ms} – standard values of distances with length up to 20 m; $v = n$ – the number of degrees of freedom, equal to the number of measured distances up to 20 m.
Error of measuring line with length 100 m, due to temperature determination error 1° and measurement error of pressure 1 mm of mercury column (which is not easy to achieve) will be equal 0.15 mm. For precise total stations a = 0.5 мм, the error of determining any interval of basis must not exceed 0.33×a = 0.16 mm. Therefore, the environmental factor is on the limit of accuracy of determining basis intervals for the compilation of such electronic total stations. But there are actually errors of intervals measurement. The phase site of basis, as a rule, is 20 m. Therefore it is better to take 20 m, then the error due to external conditions will be 0.03-0.05 mm, and will meet the requirements.	
Experimental multiplicative component of RMS errors of distances measurements … of total stations that is determined by the formula: L_i^{ms} - standard values of distances with length up to 100 m; t_a - Student distribution coefficient that is selected from the table in Annex B ISO 17123-1 according to the level of trust $P = 1 - \alpha/2$ = 0,975 and the number of degrees of freedom $v = n_a$, where n_a - general number of measured distances up to 100 m; t_b - Student distribution coefficient that is selected from the table in Annex B ISO 17123-1 according to the level of trust $P = 1 - \alpha/2$ =0,975 and the number of degrees of freedom $v = n_b$, where n_b - general number of measured distances up to 100 m;	**Experimental multiplicative component of RMS errors of distances measurements** … of total stations that is determined by the formula: L_i^{ms} - standard values of distances with length from 20 m till (0.75–1)×L_{max} (L_{max}– maximum measured distance); t_a – Student distribution coefficient that is selected from the table in Annex B ISO 17123-1 according to the level of trust $P = 1 - \alpha/2$ = 0,975 and the number of degrees of freedom $v = n_a$, where n_a – number of measured distances up to 20 m; t_b – Student distribution coefficient that is selected from the table in Annex B ISO 17123-1 according to the level of trust $P = 1 - \alpha/2$ = 0,975 and the number of degrees of freedom $v = n_b$, where n_b – number of measured distances with length from 20 m till (0.75–1)×L_{max} (L_{max}– maximum measured distance);
Usually, RMS errors of distances measurements are determined on the distances which are 0.75L, or L, where L maximum distance which is possible to measure by total station	
Constant of the kit …of reflector, which is determined by the formula: L_i^{ms} - standard values of distances with length up to 100 m; n - number of measured distances with length up to 100 m.	**Average value of instrument correction of kit** …of reflector, which is determined by the formula: L_i^{ms} – standard values of distances with length up to 20 m; n – number of measured distances with length up to 20 m.
Tachymeters are divided into electronic with single-axis or dual-axis compensators and optic with compensator or with cylindrical level at telescope and horizontal circle.	**Total stations are divided** into electronic with single-axis (compensator of vertical circle readings) or dual-axis (compensator of vertical and horizontal circles readings) compensators and

	optical-mechanical with compensator of vertical circle readings or with barrel level at alidade of vertical circle or with barrel level at telescope and alidade of horizontal circle.
In our opinion, it's better to use for electronic tacheometers the term as it is in the whole world - total stations.	
High-precision and precision theodolites are divided into electronic with single-axis or dual-axis compensators and optic with compensator or with cylindrical level at telescope and horizontal circle.	**High-precision and precision theodolites** into electronic with single-axis (compensator of vertical circle readings) or dual-axis (compensator of vertical and horizontal circles readings) compensators and optical-mechanical with compensator of vertical circle readings or with barrel level at alidade of vertical circle.
Technical theodolites are divided into electronic and optic with cylindrical level at horizontal circle. Технічні теодоліти поділяються на електронні та оптичні з циліндричним рівнем при горизонтальному крузі	Technical theodolites are divided into electronic and optical-mechanical with barrel level at telescope and alidade of horizontal circle.
RMS errors of measurements of horizontal and vertical angles … is standardized for optical and electronic theodolites and total stations when focusing on infinity (does not include centering and refocusing errors).	RMS errors of measurements of horizontal and vertical angles …. is standardized for optical-mechanical and electronic theodolites and total stations for focusing of telescope on infinity (does not include centering, reduction and refocusing errors and influence of environmental factor on both instrument and distribution of sight beam).
Magnification of telescope, times (krat) *Multiple (kratnyy), math. Which is divided into any number without a residual.*	Magnification of telescope, times (raziv) *Scientists managed to construct an electronic microscope, which magnificate in thousands times (raziv).*
Division value of circle (adjusting) level.	Division value of spherical (adjusting) level.
Deviation from perpendicularity of rotation axis telescope to axis of rotation of instrument alidade.	Non-perpendicularity of horizontal and vertical axes of instrument.
Circular level may be absent if there is cylindrical one.	A spherical level may be absent if there is a barrel.
The main standardized metrological characteristics of range finder part of electronic total stations, without consideration of centering error, are given…	The main standardized metrological characteristics of range finder part of electronic total stations, without consideration of errors of centering, reduction and determination of parameters of influence of environmental factor are given…
Actually the environment, or the external environment, rather than external conditions.	
Constant of the kit total station - reflector	Instrument correction of the kit total station - reflector

As we see, among the used terms and their meanings we come across the following:

1. Terms are given in violation of linguistic norms;

a) lexical: *coincidence/spivpadadaty* (there is no such word in the Ukrainian language), there is only *coincidence/zbih; measurement/vymiryuvannia* (it means process) and *measurement/vymir* (it means result of process) etc.;

б) morphological: *of zenth/zenita* (this is an abstract concept, therefore, it must have an end –u – *zenitu*); verb forms on – ‘*tsia’* points that action is implemented by objects themselves, and forms without postfix – *‘sia’* points that action is implemented by somebody onto objects.

2. In some illustrations, the accuracy of the notation of concepts is violated: *cylindric – barrel, distance/vidstan – distance/viddal, sphere – branch;*

3. There are inaccuracies in the interpretation of scientific concepts.

4. Own terms are proposed.

Conclusions

The table consider terminological expressions that are most commonly used in Ukrainian geodetic literature. After deliberation some of them, we came to the conclusion that some adjustments should be made both to the scientific names themselves and to their interpretation, since we believe that the Ukrainian geodesic terminology system is gradually being improved, gaining national features, refinement, and transparent motivation. Of course, we have not solved all the problems, and the examples presented in the paper may trigger discussions, but we believe that by joint efforts, we will set the order in this system.

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