ДОНСКОЙ ГОСУДАРСТВЕННЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

УПРАВЛЕНИЕ ДИСТАНЦИОННОГО ОБУЧЕНИЯ И ПОВЫШЕНИЯ КВАЛИФИКАЦИИ

Кафедра «Иностранные языки»

МЕТОДИЧЕСКИЕ УКАЗАНИЯ
по профессионально-ориентированному чтению текстов по дисциплине

«Английский язык»

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Аннотация

Методические указания по профессионально-ориентированному чтению текстов на английском языке предназначены для магистров, аспирантов и соискателей по специальности «Прикладная геодезия»

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Оглавление

UNIT 1 GEODESY AS A FIELD OF SCIENCE

Topic 1: Historic development of Geodesy

1) Answer the following questions:
a)   What is Geodesy?
b)   Who needs it and why?

New words and phrases to learn:

Applied mathematics –
прикладная математика

Terrestrial gravity –
земное притяжение

Observation –
Наблюдение

Measurement –
измерение

Satellite tracking –
слежение за
искусственным спутником
земли

Global navigation –
глобальная
навигация

2) Read the text and find the answers to the questions in Ex.1. Give your title to the text.
The subject of Geodesy

What is geodesy? Who needs it and why? These are some of the questions asked by many people. Actually, geodesy is nothing new having been around for centuries. Webster defines geodesy as "that branch of applied mathematics which determines by observation and measurement the exact positions of points and the figures and areas of large portions of the earth's surface, the shape and size of the earth, and the variations of terrestrial gravity." It is a specialized application of several familiar facets of basic mathematical and physical concepts. In practice, geodesy uses the principles of mathematics, astronomy and physics, and applies them within the capabilities of modern engineering and technology. A thorough study of the science of geodesy is not a simple undertaking. However, it is possible to gain an understanding of the historical development, a general knowledge of the methods and techniques of the science, and the way geodesy is being used to solve some Department of Defense (DoD) problems.

In the past, military geodesy was largely involved with the

practical aspect of the determination of exact positions of points on the earth's surface for mapping or artillery control purposes while the determination of the precise size and shape of the earth was a purely scientific role. However, modern requirements for distance and direction require both the practical and scientific applications of the science to provide the answers to problems in such fields as satellite tracking, global navigation and defensive missile operations.

3) Look through the text again and answer the following questions:
a)   What is the subject of Geodesy?
b)   What other science is Geodesy closely connected with?
c)   What are practical and scientific applications of the science?

4) Give a summary of the text using the following phrases:
The paper is devoted to…
It is recognized that:
It is pointed out that…
The paper puts forward the idea that…

History of Geodesy

1)   Answer the following question:
When do you think Geodesy as a science was founded?

New words and phrases to learn:

Shape of the earth – форма земли
Composition of the earth – состав земли
Circumference of the earth – окружность, периметр земли
Conservative   approximation   –   приблизительная аппроксимация
Explicit measurement – точное измерение
Summer solstice – солнечное солнцестояние
Linear distance – линейное расстояние
Deviation of the sun – отклонение, девиация солнца

2)   Read and translate the following text:
Man has been concerned about the earth on which he lives for many centuries. During very early times this concern was limited,

naturally, to the immediate vicinity of his home; later it expanded to the distance of markets or exchange places; and finally, with the development of means of transportation man became interested in his whole world. Much of this early "world interest" was evidenced by speculation concerning the size, shape, and composition of the earth.

The early Greeks, in their speculation and theorizing, ranged from the flat disc advocated by Homer to Pythagoras' spherical figure-an idea supported one hundred years later by Aristotle. Pythagoras was a mathematician and to him the most perfect figure was a sphere. He reasoned that the gods would create a perfect figure and therefore the earth was created to be spherical in shape. Anaximenes, an early Greek scientist, believed strongly that the earth was rectangular in shape.

Since the spherical shape was the most widely supported during the Greek Era, efforts to determine its size followed. Plato determined the circumference of the earth to be 40,000 miles while Archimedes estimated 30,000 miles. Plato's figure was a guess and Archimedes' a more conservative approximation. Meanwhile, in Egypt, a Greek scholar and philosopher, Eratosthenes, set out to make more explicit measurements.

He had observed that on the day of the summer solstice, the midday sun shone to the bottom of a well in the town of Syene (Aswan). At the same time, he observed the sun was not directly overhead at Alexandria; instead, it cast a shadow with the vertical equal to l/50th of a circle (7° 12'). To these observations, Eratosthenes applied certain "known" facts (1) that on the day of the summer solstice, the midday sun was directly over the line of the summer Tropic Zone (Tropic of Cancer)-Syene was therefore concluded to be on this line; (2) the linear distance between Alexandria and Syene was 500 miles; (3) Alexandria and Syene lay on a direct northsouth line.

From these observations and "known" facts, Eratosthenes concluded that, since the angular deviation of the sun from the vertical at Alexandria was also the angle of the subtended arc, the linear distance between Alexandria and Syene was 1/50 of the circumference of the earth or 50 x 500 = 25,000 miles. A currently accepted value for the earth's circumference at the Equator is 24,901 miles, based upon the equatorial radius of the World Geodetic System (Chapter VIII). The actual unit of measure used by Eratosthenes was called the "stadia." No one knows for sure what the stadia that he used is in today's units. The measurements given above in miles were derived using one stadia equal to one-tenth statute mile.

It is remarkable that such accuracy was obtained in view of the fact that most of the "known" facts and his observations were incorrect: (1) although it is true that the sun at noon is directly overhead at the Tropic of Cancer on the day of the summer solstice, it was erroneously concluded that Syene lay on the line. Actually, Syene is 37 miles to the north; (2) the true distance between Alexandria and Syene is 453 miles and not 500; (3) Syene lies 3° 30' east of the meridian of Alexandria; (4) the difference of latitude between Alexandria and Syene is 7° 5' rather than 7° 12' as Eratosthenes had concluded.

Another ancient measurement of the size of the earth was made by the Greek, Posidonius. He noted that a certain star was hidden from view in most parts of Greece but that it just grazed the horizon at Rhodes. Posidonius measured the elevation of the same star at Alexandria and determined that the angle was l/48th of circle. Assuming the distance from Alexandria to Rhodes to be 500 miles, he computed the circumference of the earth as 24,000 miles. While both his measurements were approximations when combined, one error compensated for another and he achieved a fairly accurate result.

Revising the figures of Posidonius, another Greek philosopher determined 18,000 miles as the earth's circumference. This last figure was promulgated by Ptolemy through his world maps. The maps of Ptolemy strongly influenced the cartographers of the middle ages. It is probable that Columbus, using such maps, was led to believe that Asia was only 3 or 4 thousand miles west of Europe. It was not until the 15th century that his concept of the earth's size was revised. During that period the Flemish cartographer, Mercator, made successive reductions in the size of the Mediterranean Sea and all of Europe which had the effect of increasing the size of the earth.

The telescope, logarithmic tables, and the method of triangulation were contributed to the science of geodesy during the 17th century. In the course of the century, the Frenchman, Picard, performed an arc measurement that is modern in some respects. He measured a base line by the aid of wooden rods, used a telescope in his angle measurements, and computed with logarithms. Cassini later continued Picard's arc northward to Dunkirk and southward to the Spanish boundary. Cassini divided the measured arc into two parts, one northward from Paris, another southward. When he computed the length of a degree from both chains, he found that the length of one degree in the northern part of the chain was shorter than that in the southern part. This unexpected result could have been caused only by an egg-shaped earth or by observational errors.

The results started an intense controversy between French and English scientists. The English claimed that the earth must be flattened, as Newton and Huygens had shown theoretically, while the Frenchmen defended their own measurement and were inclined to keep the earth egg-shaped.

To settle the controversy, once and for all, the French Academy of Sciences sent a geodetic expedition to Peru in 1735 to measure the length of a meridian degree close to the Equator and another to Lapland to make a similar measurement near the Arctic Circle. The measurements conclusively proved the earth to be flattened, as Newton had forecast. Since all the computations involved in a geodetic survey are accomplished in terms of a mathematical surface (reference ellipsoid) resembling the shape of the earth, the findings were very important.

3)   Match two columns and make the collocations:

1. to measure
2. to compute
3. to determine
4. to make
5. to observe

a) the size
b) errors
c) a base line
d) the elevation
e) the length of a degree
f) the circumference of the earth
g) measurements
h) the sun

4)   Look through the text again and answer the following questions:

1. What limited the early "world interest" to the earth?
2. Who was the first scholar interested in the shape and size of the earth?
3. What kind of observations did Eratosthenes make?
4. Were Eratosthenes observations correct? Why? Give your proofs.
5. Who else measured the size of the earth?
6. Did he achieve a fairly accurate result?
7. Whose maps strongly influenced the cartographers of the Middle ages?
8. What were Columbus's beliefs?
9. What geodetic tools were invented during the 17th century?

10. How many scientists were engaged in geodetic survey of the earth?

11. What was the aim of geodetic expedition to Peru in 1735?

5) Read the following statements and say whether they are true or false (T/F). If the statement is wrong, correct it.

Use the following phrases: That's right… No objections… I don't think it's right… That's wrong… According to the text…

1. During very early times the concern about the earth was limited to the immediate vicinity of man's home.

2. The early Romans speculated about the size of the earth.

3. According to Pythagoras the most perfect figure was a rectangular.

4. Plato determined the circumference of the earth to be 40,000 miles.

5. The midday sun shone to the bottom of a well in the town of Rome.

6. The linear distance between Alexandria and Syene was 600 miles.

7. The actual unit of measure used by Eratosthenes was called 'stadia'

8. Another ancient measurement of the size of the earth was mad by the Greek.

9. Posidonius measured the elevation of different stars at Syene.

10. The maps of Ptolemy strongly influenced the cartographers of middle ages.

6) Find in the text the English equivalents for the following words and word combinations:

1. идеальная фигура
2. периметр земли
3. летнее солнцестояние
4. сделать заключение
5. точность
6. вычислить окружность земли
7. логарифмическая таблица
8. измерить базисную линию
9. произвести измерения
10. геодезическое исследование, съемка

7) Make up a plan of the text and find the key- words to

each point of your plan in the text.

8) Render the text according to your own opinion using the following phrases:

I don't think the information is of great value.

To my mind the text is intended for those who are interested in…

Topic 2: Figure of the Earth

1) Answer the following questions:

What is the concern of topographers and hydrographers?

New words and phrases to learn:

Irregularities of the earth –
неровности земли

Dimension –
размер

Axis –
ось

Bulge –
выгнутость, кривизна

Plane-table survey –
мензульная съемка

Flattening –
выравнивание

Triaxial –
пространственный,
трехмерный

Elevation –
угол возвышения

2) Read the following text and give your title to it:

The expression "figure of the earth" has various meanings in geodesy according to the way it is used and the precision with which the earth's size and shape is to be defined. The actual topographic surface is most apparent with its variety of land forms and water areas. This is, in fact, the surface on which actual earth measurements are made. It is not suitable, however, for exact mathematical computations because the formulas which would be required to take the irregularities into account would necessitate a prohibitive amount of computations. The topographic surface is generally the concern of topographers and hydrographers.

The Pythagorean spherical concept offers a simple surface

which is mathematically easy to deal with. Many astronomical and navigational computations use it as a surface representing the earth. While the sphere is a close approximation of the true figure of the earth and satisfactory for many purposes, to the geodesists interested in the measurement of long distances-spanning continents and oceans-a more exact figure is necessary. The idea of flat earth, however, is still acceptable for surveys of small areas. Plane-table surveys are made for relatively small areas and no account is taken of the curvature of the earth. A survey of a city would likely be computed as though the earth were a plane surface the size of the city. For such small areas, exact positions can be determined relative to each other without considering the size and shape of the total earth. Since the earth is in fact flattened slightly at the poles and bulges somewhat at the equator, the geometrical figure used in geodesy to most nearly approximate the shape of the earth is an ellipsoid of revolution. The ellipsoid of revolution is the figure which would be obtained by rotating an ellipse about its shorter axis. An ellipsoid of revolution is uniquely defined by specifying two dimensions. Geodesists, by convention, use the semimajor axis and flattening. The size is represented by the radius at the equator-the semimajor axis-and designated by the letter, a. The shape of the ellipsoid is given by the flattening, f, which indicates how closely an ellipsoid approaches a spherical shape. The difference between the ellipsoid of revolution representing the earth and a sphere is very small. The ellipsoids listed below have had utility in geodetic work and many are still in use. The older ellipsoids are named for the individual who derived them and the year of development is given. The international ellipsoid was developed by Hayford in 1910 and adopted by the International Union of Geodesy and Geophysics (IUGG) which recommended it for international use.

At the 1967 meeting of the IUGG held in Lucerne, Switzerland, the ellipsoid called GRS-67 in the listing was recommended for adoption. The new ellipsoid was not recommended to replace the International Ellipsoid (1924), but was advocated for use where a greater degree of accuracy is required. It became a part of the Geodetic Reference System 1967 which was approved and adopted at the 1971 meeting of the IUGG held in Moscow. It is used in Australia for the Australian Geodetic Datum and in South America for the South American Datum 1969.

The ellipsoid called GRS-80 (Geodetic Reference System 1980) was approved and adopted at the 1979 meeting in Canberra, Australia.

The possibility that the earth's equator is an ellipse rather than a circle and therefore that the ellipsoid is triaxial has been a matter of scientific controversy for many years. Modern technological developments have furnished new and rapid methods for data collection and since the launching of the first Russian sputnik, orbital data has been used to investigate the theory of ellipticity.

A second theory, more complicated than triaxiality, proposed that satellite orbital variations indicate additional flattening at the south pole accompanied by a bulge of the same degree at the north pole. It is also contended that the northern middle latitudes were slightly flattened and the southern middle latitudes bulged in a similar amount. This concept suggested a slight pearshaped earth and was the subject of much public discussion. Modern geodesy tends to retain the ellipsoid of revolution and treat triaxiality and pear shape as a part of the geoid separation (to be discussed later).

3) Read the text again and answer the following questions:

a) What "meanings" does the expression "figure of the earth" have?

b) Who is the idea of flat earth still acceptable for?

c) Who developed and adopted the international ellipsoid?

d) What does GRS-80 mean?

e) What does modern geodesy tend to retain?

4) Complete the following sentences using the text:

1. The actual topographic surface is most apparent with…

2. The topographic surface is generally concern of…

3. Many astronomical and navigation computations use… as a surface representing the earth

4. The idea of… is still acceptable for…

5. … are made for small areas.

6. The ellipsoid of revolution is the figure…

7. Geodesists? By convention, use…

8. The international ellipsoid was developed by… in…

5) Give the summary of the text using the following phrases:

The paper reports on…

It covers such points as….

Much attention is given to…

It is pointed out that…

The paper is of interests for…

Topic 3: Geoid

1) Answer the following questions:
What other surface is involved in geodetic measurement?

New words and phrases to learn:

Geoid – геоид

To coincide – совпадать

Rotation – вращение

Computations – вычисления

Centrifugal force – центробежная сила

2) Scan the following text and find the definition of geoid:

It was stated earlier that measurements are made on the apparent or topographic surface of the earth and it has just been explained that computations are performed on an ellipsoid. One other surface is involved in geodetic measurement-the geoid. In geodetic surveying, the computation of the geodetic coordinates of points is performed on an ellipsoid which closely approximates the size and shape of the earth in the area of the survey. The actual measurements made on the surface of the earth with certain instruments are referred to the geoid, as explained below. The ellipsoid is a mathematically defined regular surface with specific dimensions. The geoid, on the other hand, coincides with that surface to which the oceans would conform over the entire earth if free to adjust to the combined effect of the earth's mass attraction and the centrifugal force of the earth's rotation. As a result of the uneven distribution of the earth's mass, the geoidal surface is irregular and, since the ellipsoid is a regular surface, the two will not coincide. The separations are referred to as geoid undulations, geoid heights, or geoid separations.

The geoid is a surface along which the gravity potential is

everywhere equal and to which the direction of gravity is always perpendicular. The later is particularly significant because optical instruments containing leveling devices are commonly used to make geodetic measurements. When properly adjusted, the vertical axis of the instrument coincides with the direction of gravity and is, therefore, perpendicular to the geoid. The angle between the plumb line which is perpendicular to the geoid (sometimes called "the vertical") and the perpendicular to the ellipsoid (sometimes called "the normal") is defined as the deflection of the vertical

3) Read the text again and give the summary of it using the following phrases:

a) The paper deals with…
b) It was stated that…
c) The definitions of…are given here
d) It is found that…
e) The paper concentrates on…

UNIT 2. GEODETIC SURVEYING TECHNIQUES

Topic 1: Geodetic Surveying

1) Answer the following question:

What other fields of science is geodetic surveying connected with?

New words and phrases to learn:

To delineate – точно воспроизводить местность

Astronomic positioning – астрономическая регулировка положения

Triangulation – триангуляция

Trilateration – трилитерация (измерение по трём сторонам треугольника

Traverse – трасса, поперечина

2) Read and translate the following text:

3) Look through the text again and answer the following question:

1. What is the definition of "survey" according to the dictionary?
2. What is the function of geodesy?
3. What are traditional surveying techniques?
4. What are their functions?
5. How can the position of a point be obtained?
6. What is the oldest positioning method?
7. Why have explorers often used the astronomic method?
8. What must geodesists use astronomic position for?
9. How are astronomic positions obtained?
10. What is the simplest geodetic surveying method?
11. What problems are the operations closely associated?

4) Match two columns and make the collocations:

1. to take	a) linear and angular measurements
2. to apply	b) the positions of paints
3. to determine	c) the direction of the plumb line
4. to utilize	d) precise techniques

5. to obtain   e) artificial earth satellites
6. to establish   f) the principles of geometry
                                and trigonometry
7. to compute

5) Explain in English the following notions using the text:
1.   astronomic latitude
2.   astronomic longitude
3.   astronomic positions
4.   plumb line
5.   Greenwich

6) Make up a plan of the text using keyboard from it.

7) Render the text according to your plan. Express your opinion about the significance of information.

Topic 2: Astronomic coordinates

1)   Answer the following questions:
What role does astronomy play in geodetic surveying?

New words and phrases to learn:

Meridian plane of the point – плоскость меридиана точки
Chronometer – хронометр
Clockwise – почасовой стрелке

2)   Read the following text and word the main idea of it:
Actually, astronomic longitude is measured by determining the difference in time-the difference in hours, minutes, and seconds between the time a specific star is directly over the Greenwich meridian and the time the same star is directly over the meridian plane of the point. Shortwave radio equipment is used to obtain time signals which can be referred to Greenwich Mean Time while chronometers (very accurate clocks) are used to measure the time at the point. By referring to a star catalogue, the exact Greenwich Mean Time the star was over the Prime Meridian is obtained. The difference between the time at the point and the time at Greenwich is

used to compute the astronomic longitude of the point. Since a point of the earth rotates through 360° in 24 hours, the difference in local time between two points can be easily converted into difference in longitude.

Another astronomic observation related to horizontal positioning is the astronomic azimuth. Very accurate azimuths are used in the controlling of the orientation of first-order triangulation which is the next topic to be discussed. The astronomic azimuth of some other point is defined as the angle between the meridian plane of point P and the plane containing both Q and the perpendicular to the geoid at P. This angle is reckoned from north at P clockwise from 0° to 360°.

Astronomic observations are made by optical instruments-theodolite, zenith camera, prismatic astrolabe-which all contain leveling devices. When properly adjusted, the vertical axis of the instrument coincides with the direction of gravity and is, therefore, perpendicular to the geoid. Thus, astronomic positions are referenced to the geoid. Since the geoid is an irregular, nonmathematical surface, astronomic positions are wholly independent of each other.

3) Look through the text again and answer the following questions:

a) How is astronomic longitude measured?

b) What is short-wave radio equipment used for?

c) What is a chronometer?

d) What other astronomic observation related to horizontal positioning do you know?

e) How is astronomic azimuth of some other point defined?

f) What kind of optical instruments do you know?

4) Read the following statements and say whether they are true or false (T/F). If the statement is wrong, correct it.

Use the following phrases: That's right… No objections… I don't think it's right… That's wrong… According to the text…

1. Short-wave radio equipment can not be used to obtain time signals.

2. The difference between the time at the point and the time at Greenwich is used to compute the astronomic longitude of the point.

3. A point of the earth rotates through 180° in 24 hours.

4. The astronomic azimuth is another astronomic observation.

5. Theodolite, zenith camera, prismatic astrolable don't contain leveling devices.

6. Astronomic positions are referenced to the geoid.

5) Complete the following sentences:
1. Astronomic longitude is measured by…
2. Shortwave radio equipment is used to…
3. Chronometers are…
4. The difference between the time as the point and the time at Greenwich is used to…
5. Very accurate azimuths are used in…

Triangulation

1) Answer the following questions:
What types of geodetic survey do you know?

New words and phrases to learn:

Plane survey – мензульная съёмка
Instrumental errors – инструментальные погрешности
A base line – базисная линия, магистральный ход
Invar – инвар (железоникелевый сплав)
Geodimeter – геодиметр, электроннооптический дальномер
Tellurometer – теллюрометр (земной)
An arc of triangulation – дуга триангула

2) Read and translate the following text:
The most common type of geodetic survey is known as triangulation. It differs from the plane survey mentioned earlier in that more accurate instruments are used, instrumental errors are either removed or predetermined so that they can be compensated for in the computations and more rigorous procedures are employed to reduce observational errors. Another very important difference is that all of the positions established by triangulation are mathematically related to each other.

Basically, triangulation consists of the measurement of the angles of a series of triangles. The principle of triangulation is based on simple trigonometric procedures. If the distance along one side of a triangle and the angles at each end of the side are accurately measured, the other two sides and the remaining angle can be computed. Normally, all of the angles of every triangle are measured for the minimization of error and to furnish data for use in computing the precision of the measurements. Also, the latitude and longitude of one end of the measured side along with the length and direction (azimuth) of the side provide sufficient data to compute the

latitude and longitude of the other end of the side.

The measured side of the base triangle is called a base line. Measurements are made as carefully and accurately as possible with specially calibrated tapes or wires of invar, an alloy highly resistant to changes in length resulting from changes in temperature. The tapes or wires are checked periodically against standard measures of length (at the Bureau of Standards in the United States and corresponding agencies in other countries). The geodimeter and tellurometer, operating on electro-optical and electronic principles respectively, have replaced the older methods of base measurement in the recent surveys. The work can be completed more rapidly and accurately than with wire or tape. The laser equipped geodimeter has proven to be the most accurate and it can measure much longer distances without losing accuracy.

To establish an arc of triangulation between two widely separated locations, a base line may be measured and longitude and latitude determined for the initial point at one end. The locations are then connected by a series of adjoining triangles forming quadrilaterals extending from each end. Figure 7. With the longitude, latitude, and azimuth of the initial points, similar data is computed for each vertex of the triangles thereby establishing triangulation stations or geodetic control stations. The coordinates of each of the stations are defined as geodetic coordinates.

Triangulation is extended over large areas by connecting and extending series of arcs and forming a network or triangulation system. The network is adjusted in a manner which reduces the effect of observational errors to a minimum. A denser distribution of geodetic control is achieved in a system by subdividing or filling in with other surveys.

3) Read the text again and answer the following questions:

a) What are the main differences between triangulation and the plane survey?

b) What does triangulation consist of?

c) What is its principal based on?

d) What are all of the angles of every triangle measured for?

e) What provides sufficient data to compute the latitude and longitude of the other end of the end of the side?

f) What is called a base line?

g) How can a base line be measured?

4) Match two columns and make the collocations:

1. azimuth
2. invar
3. geodetic coordinates

a. the coordinates of each of the stations
b. direction of the side
c. an alloy highly resistant to resulting from changes in temperature

5) Find in the text the English equivalents for the following words and word combinations:

1. геодезическая съёмка
2. мензульная съёмка
3. инструментальные погрешности
4. простые тригонометрические действия
5. базисная линия
6. прилегающие треугольники

Topic 3: Fundamental Geodetic Networks (Horizontal Control)

1) Answer the following questions:

What does the word "network" mean?
What kind of networks do you know?

New words and phrases to learn:

Framework of horizontal control – рамка горизонтального контроля

High value land areas – участки земли, предоставляющие особую ценность

Hydrographic survey – гидрографическая съёмка

Identifiable object – идентифицированный ориентир

2) Read and translate the following text:

There are four general orders of triangulation. First-Order (Primary Horizontal Control) is the most accurate triangulation. It is costly and time-consuming using the best instruments and rigorous computation methods. First-Order triangulation is usually used to provide the basic framework of horizontal control for a large area such as for a national network. It has also been used in preparation for

metropolitan expansion and for scientific studies requiring exact geodetic data. Its accuracy should be at least one part in 100,000.

Second-Order, Class I (Secondary Horizontal Control) includes the area networks between the First-Order arcs and detailed surveys in very high value land areas. Surveys of this class strengthen the US National Horizontal Control Network and are adjusted as part of the network.

Therefore, this class also includes the basic framework for further densification. The internal closures of Second-Order, Class I triangulation should indicate an accuracy of at least one part in 50,000. The demands for reliable horizontal control surveys in areas which are not in a high state of development or where no such development is anticipated in the near future justifies the need for a triangulation classified as Second-Order, Class II (Supplemental Horizontal Control). This class is used to establish control along the coastline, inland waterways and interstate highways. The control data contributes to the National Network and is published as part of the network. The minimum accuracy allowable in Class II of Second-Order is one part in 20,000.

Third-Order, Class I and Class II (Local Horizontal Control) is used to establish control for local improvements and developments, topographic and hydro graphic surveys, or for such other projects for which they provide sufficient accuracy. This triangulation is carefully connected to the National Network. The work should be performed with sufficient accuracy to satisfy the standards of one part in 10,000 for Class I and one part in 5,000 for Class II. Spires, stacks, standpipes, flag poles and other identifiable objects located to this accuracy also have significant value for many surveying and engineering projects.

The sole accuracy requirement for Fourth-Order triangulation is that the positions be located without any appreciable errors on maps compiled on the basis of the control.

Normally, triangulation is carried out by parties of surveyors occupying preplanned locations (stations) along the arc and accomplishing all the measurements as they proceed. When distances between two points were too long for conventional methods, connections were sometimes made by a method known as flare triangulation. Stations were occupied on either side of the gap and magnesium flares were parachuted from aircraft or "shot" into the air from ships at suitable points between them. Intersections of lines were made simultaneously at all of the stations and reasonably accurate "bridges" established. A connection of this type was

established between Norway and Denmark. However, satellite geodesy has solved the problem of bridging wide gaps.

Another surveying method that has been used involves the use of radar and aircraft. The SHORAN, HIRAN and SHIRAN electronic distance measuring systems have been applied to performing geodetic surveys by a technique known as trilateration. Since very long lines (to 500 miles) could be measured by these systems, geodetic triangulation networks have been extended over vast areas in comparatively short periods of time. In addition, the surveys of islands and even continents separated by extensive water barriers have been connected by the techniques. The Canadian SHORAN network connecting the sparsely populated northern coastal and island areas with the central part of the country and the North Atlantic HIRAN Network tying North America to Europe are examples of the application of the trilateration technique. Shows these and several other trilateration networks (SHORAN and HIRAN) which have been established throughout the world. SHIRAN has been used in the interior of Brazil.

Only distances are measured in trilateration and each side is measured repeatedly to insure precision. The entire network is then adjusted to minimize the effects of the observations errors. The angles of the triangles are computed so the geodetic positions are obtained as in triangulation.

3) Look through the text again and answer the following question:

1. What is costly and time- consuming order of triangulation?
2. What is the purpose of First- Order of triangulation?
3. What does Second- Order, Class I includes?
4. Which class of surveys strengthens the US National Horizontal Control Network?
5. What accuracy should the internal closures of Second-Order, Class I indicate?
6. What is Second-Order, Class II used for?
7. What is the minimum accuracy allowable in Class II of Second- Order?
8. What is Local Horizontal Control used for?
9. What identifiable object located to the accuracy of Class I and Class II have significant value for surveying projects?
10. How is triangulation carried out normally?
11. What does flare triangulation mean?
12. What problem has satellite geodesy solved?

13. What surveying method involves the use of radar and aircraft?

14. What are the examples of the application of the trilateration technique?

4) Complete the following sentences:
1. First-Order triangulation is called…
2. First-Order triangulation is used to…
3. Second-Order, Class I triangulation is called…
4. Second-Order, Class I triangulation includes…
5. Second-Order, Class II triangulation is called…
6. Second-Order, Class II triangulation is used to…
7. …is carefully connected to the National Network.
8. Another surveying method involves the use of…

5) Make up a detailed plan of the text.

6) Render the text according to your plan.

Topic 4: Traverse and Celestial Techniques

1) Answer the following questions:
What other types of surveying do you know?

New words and phrases to learn:
Electronic distance measuring equipment – электронное измерительное оборудование

Loop length – бугельная длина

Loop closure – бугельный затвор

Solar eclipse – солнечное затмение

Star occultation – звездное затмение

2) Read and translate the following text:
The simplest method of extending control is called traverse. The system is similar to dead reckoning navigation where distances and directions are measured. In performing a traverse, the surveyor starts at a known position with a known azimuth (direction) to another point and measures angles and distances between a series of survey points. With the angular measurements, the direction of each line of the traverse can be computed; and with the measurements of the length of the lines, the position of each control point

computed. If the traverse returns to the starting point or some other known position, it is a closed traverse, otherwise the traverse is said to be open.

Since electronic distance measuring equipment has become available, the accuracy of traverse surveys has increased significantly. The tellurometer (microwave) has been used in Australia to complete a network (Australian Geodetic Datum) covering that continent. The average loop length is about 900 miles; the average loop closure of this work is 2.2 parts per million. The laser equipped geodimeter has been used to produce internal accuracies better than one part per million in establishing the transcontinental traverse in the United States. The traverse consists of a series of high-precision length, angle and astronomic azimuth determinations running approximately east-west and north-south through the conterminous states, forming somewhat rectangular loops. This traverse will be the "backbone" of a re-adjustment of the horizontal control network in this country.

A celestial method in geodesy involves the determination of an observer's position from observations of the moon, stars and satellites. Celestial triangulation permits the extension of long arcs across oceans and inaccessible space terrain. Satellites also permit a determination of the shape of the earth and provide important knowledge of its gravitational field. All of the celestial methods possess one common characteristic-observed data is not affected by the direction of the vertical at the observation point.

Geodetic experiments have been performed in the past with the solar eclipse, star occultation and moon-position camera methods, but for various reasons the experiments did not produce useful geodetic results. The three techniques have been replaced by the observation and tracking of artificial earth satellites.

3) Look through the text again and answer the following question:

1. What does the surveying start with in performing a traverse?
2. What is called a "closed traverse"?
3. What is called a "open traverse"?
4. What equipment increased the accuracy of traverse surveys?
5. What will be "the backbone" of a readjustment of the horizontal control network?
6. What do celestial methods in geodesy involve?
7. What three technigues helped to make geodetic experiments in the past?

4) Read the following statements. Say if they are true or not (T/F).If they are false, correct them.

1. The simplest method of extending control is called triangulation.

2. In performing a traverse, the surveyor starts at an unknown position with a know azimuth.

3. Celestial triangulation permits the extension of long arc across oceans and inaccessible space terrain.

4. Solar eclipse, star occultation and moon-positron camera methods produced useful geodetic results in the past.

5) Give a summary of the text using the following phrases:

The paper is devoted to the problem of …
At the beginning it informs the reader that…
Further it says that…
Much attention is paid to …
It is pointed out that …

Topic 5. Vertical Positioning and Methods of Elevation Determination

1) Answer the following question:
-What geodetic data for mapping purposes do you need to have?

New words and phrases to learn

Undulation of the geoid – волнообразная поверхность геоида
Gauge – манометр
Exploratory survey – глазомерная съемка

2) Read and translate the following text:
Vertical surveying is the process of determining heights-elevations above the mean sea level surface. As noted earlier, the geoid corresponds to the mean level of the open sea. In geodetic surveys executed primarily for mapping purposes, there is no problem in the fact that geodetic positions are referred to an ellipsoid and the elevations of the positions are referred to the geoid. However, geodetic data for missiles requires an adjustment in the elevation information to compensate for the undulations of the geoid above and below the regular mathematical surface of the ellipsoid. The

adjustment uses complex advanced geodetic techniques. One method based on Stokes' Theorem is mentioned in the discussion of physical geodesy.

Precise geodetic leveling is used to establish a basic network of vertical control points. From these, the height of other positions in the survey can be determined by supplementary methods. The mean sea level surface used as a reference (vertical datum) is determined by obtaining an average of the hourly water heights for a period of several years at tidal gauges.

There are three leveling techniques-differential, trigonometric, and barometric-which yield information of varying accuracy. Differential leveling is the most accurate of the three methods. With the instrument locked in position, readings are made on two calibrated staffs held in an upright position ahead of and behind the instrument. The difference between readings is the difference in elevation between the points.

The optical instrument used for leveling contains a bubble tube to adjust it in a position parallel to the geoid. When properly "set up" at a point, the telescope is locked in a perfectly horizontal (level) position so that it will rotate through a 360 arc. The exact elevation of at least one point in a leveling line must be known and the rest computed from it.

Trigonometric leveling involves measuring a vertical angle from a known distance with a theodolite and computing the elevation of the point. With this method, vertical measurements can be made at the same time horizontal angles are measured for triangulation. It is, therefore, a somewhat more economical method but less accurate than differential leveling. It is often the only practical method of establishing accurate elevation control in mountainous areas.

In barometric leveling, differences in height are determined by measuring the difference in atmospheric pressure at various elevations. Air pressure is measured by mercurial or aneroid barometers, or a boiling point thermometer. Although the degree of accuracy possible with this method is not as great as either of the other two, it is a method which obtains relative heights very rapidly at points which are fairly far apart. It is widely used in the reconnaissance and exploratory surveys where more exacting measurements will be made later or are not required.

3) Look through the text and answer the following questions:
1. What kind process is vertical 24. Surveying?

2.   Why do geodetic data for missiles require an adjustment in the elevation information?

3.   What is precise geodetic leveling used for?

4.   How many leveling techniques do you know?

5.   What is the most accurate leveling?

6.   What does optical instrument for leveling contain?

7.   What kind of leveling involves measuring a vertical angle from a known distance?

8.   How are differences in barometric leveling determined?

4) Make up a plan of the text and render it according to you plan.