ISSN 1606-146X

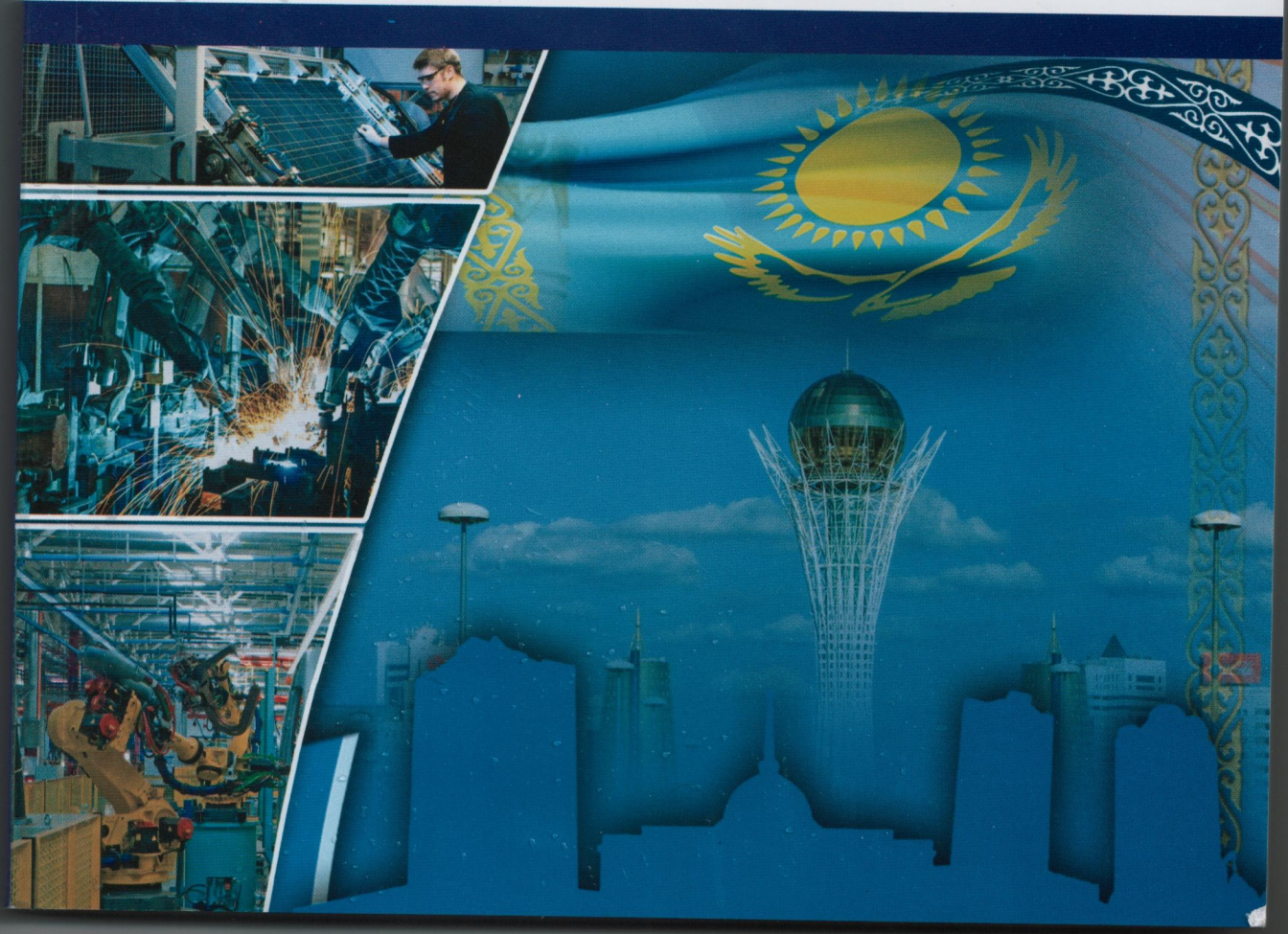
№ 4 (66)
2017

Қазақстан Республикасы
Ұлттық инженерлік академиясының

ХАБАРШЫСЫ

ВЕСТНИК

Национальной инженерной академии
Республики Казахстан



МЕЖДУНАРОДНЫЙ
НАУЧНО-ТЕХНИЧЕСКИЙ ЖУРНАЛ
ВЕСТНИК НАЦИОНАЛЬНОЙ ИНЖЕНЕРНОЙ АКАДЕМИИ РК

INTERNATIONAL
SCIENTIFICALLY-TECHNICAL JOURNAL
HERALD TO NATIONAL ENGINEERING ACADEMY
OF THE REPUBLIC OF KAZAKHSTAN

УЧРЕДИТЕЛЬ:

Республиканское общественное объединение
«Национальная инженерная академия Республики Казахстан».

Издается с 1997 года.

Выходит 4 раза в год.

Свидетельство о регистрации издания № 287 от 14.11.1996 г.,
выдано Национальным агентством по делам печати и массовой информации
Республики Казахстан.

Свидетельство о перерегистрации № 4636-Ж от 22.01.2004 г.,
выдано Министерством информации Республики Казахстан.

Журнал включен Комитетом науки Министерства образования и науки Республики Казахстан в перечень изданий для публикации основных результатов научно-технических работ соискателей ученых степеней доктора философии PhD и доктора по профилю и ученых званий доцента и профессора.

Журнал включен в международную англоязычную базу реферативных данных по техническим наукам INSPEC.

Подписку на журнал можно оформить в отделениях связи АО «Казпочта»,
ТОО Агенстве «Евразия пресс» и ТОО Агенстве «Еврика пресс».

Подписной индекс:

для физических лиц – **75188,**
для юридических лиц – **25188.**

Подписка продолжается в течение года.

Адрес редакции: 050010, г. Алматы, ул. Богенбай батыра, 80, к. 415.

Тел. 8-7272-915290, факс: 8-7272-915190,

e-mail: **nia_rk@mail.ru, ntpneark@mail.ru, www.neark.kz**

ISSN 1606–146X

FOUNDER:

Republic public association
"National Engineering Academy of the Republic of Kazakhstan".

Published since 1997 year.

Issued 4 times a year.

Certificate about registration the edition N 287, November, 14, 1996,
was given by National agency on affaires of press and mass information
of the Republic of Kazakhstan.

Certificate about re-registration N 4636-Zh, January, 22, 2004,
was given by Ministry of information of the Republic of Kazakhstan.

The Committee of Science of Ministry of Education and Science of the Republic of Kazakhstan has included the Journal into the list of issues for publication of the main results of scientific-technical investigations of applicants for scientific degrees (Doctor philosophy PhD, Doctor on specialization) and academic ranks (Professor and Associate professor).

The Journal was included into international English-language abstracts database on technical sciences "INSPEC".

Subscription to journal may be drawn up at post offices of OJSC "Kazpochta",
in PLL Agency "Evraziya press" and PLL Agency "Evrika press" .

Subscription index:

for natural persons – **75188**,
for juristic persons – **25188**.

Subscription continues during a year.

Address of editorial offices: 050010, Almaty city, Bogenbay Batyr str., 80, off. 415.

Tel. 8-7272-915290, fax: 8-7272-915190,

e-mail: **nia_rk@mail.ru, ntpneark@mail.ru, www.neark.kz**

ISSN 1606–146X

ЭКОНОМИКА

МАТЕРИАЛЫ КРУГЛОГО СТОЛА WSEC -2017

ЮБИЛЕЙНЫЕ ДАТЫ

A. ZH. ZHUSSUPBEKOV, R. E. LUKPANOV, D. V. TSYGULYOV and D. K. ORAZOVA

Department of Civil Engineering, Eurasian National University, Astana, Kazakhstan
astana-geostroi@mail.ru

RESEARCHES OF VIBRATING INFLUENCE OF WIND POWER TOWER TO THE FOUNDATION

The paper shows results of vibromonitoring of wind power tower (WPT). The analysis of vibrating influence from the tower fluctuating load on WPU foundation had been made by the results of in-situ monitoring. The results of research are presented in diagram dependence of vibrating characteristics (frequency, amplitude, acceleration) from wind pressure intensity. There was given an extrapolation of potential efforts arising in the foundation at maximum wind load in that region. There also were given the recommendations in choosing optimal foundation in engineering-geological and climate conditions of WPU.

Introduction. Wind power is the most dynamically developing type of renewable energy sources. Having studied the energy potential of wind in Kazakhstan, the Government of the Republic of Kazakhstan together with the UN development Program "Kazakhstan is the initiative of the development of wind power market" has resolved that the Ereymentau district of Akmola region is the most perspective area for the construction of wind power stations (National program 2007).

The first steps in the Program realization were taken in Ereymentau district of Akmola region.

Currently 22 WPUs have been maintained. They are connected to Ekibastuz power transmission line and supply Ereymentau district, Erkenshilik settlement, and Astana city (partially) with electrical power.

Within the context of an upcoming exhibition "EXPO-2017" in Astana it is planned to provide power supply of the exhibition facilities by using the energy of Ereymentau WPS.

Construction site description. The areas for WPU building are located on the territory free from construction. The prevailing forms of relief are dome-shaped bald mountains composed of dense rocks. The bald mountains are separated by dry small ravines and blind creek lowlands which are confined to less resistant rocks. The relative excess of bald mountains ranges from 30 to 110 meters .

The geological structure of this territory includes sedimentary and metamorphic rocks of the Proterozoic and Paleozoic periods which are broken out by intrusions in the North-Eastern part of the city, overlaid by residual and talus quartenary sediments consisted of clay loams, sand loams and loams with land waste and broken stone, loam and clay loam saprolites, broken stone-land waste and land waste-broken stone subsoil with sand and clay loam filler (Technical Norms and Regulations 1987).

The procedure of variations and vibrations measuring with the help of vibra profound indicator. The field studies and measuring vibrational effect on WGU foundation were made with the help of VIBRA Profound indicators. These instruments allow defining

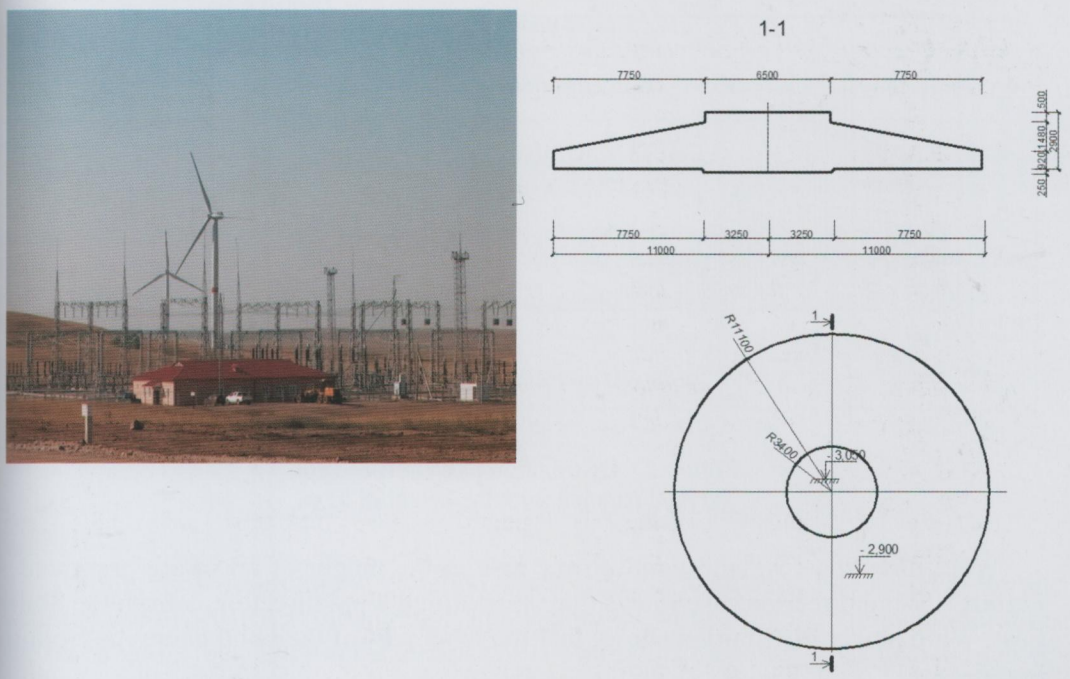


Figure 1 – Current Ereymentau WPS and slab foundation
It was decided to use slab foundation with the diameter of 22 m as the foundation.

the speed, acceleration, vibration frequency and foundation displacement caused by wind pressure.

The instrument system meets national and international standards SBR 2002, DIN 4150 and DIN 45669.

The procedure of measuring included:

Vibrational effect measurements were made at the site in Ereymentau in September, 26-27, 2015.

First, the indicator was set on WGU foundation at the distance of 100 mm from the tower block. Then it was set on WGU tower block.

The standard of measuring meets international standards DIN 4150 and DIN 45669.

Temporary measuring was counted out every 10 seconds.

The estimation of wind potential at WPS sit. Annual measurements of speed and direction of wind were made at the site within the context of UNDP project on wind power. Measurements were performed in accordance with international standards in the field of measuring wind speed in order to estimate wind potential (IEA/IEC) [2].

The distribution of wind speed and Weibull parameters at the height of 51 m (the axis of the gondola) for the site of Ereymentau WPS are shown in Figure 2.

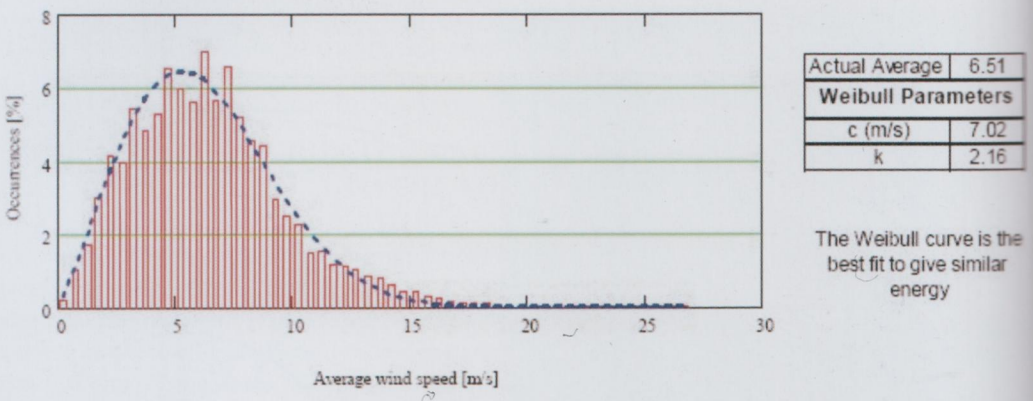


Figure 2 – Distribution of wind speed and Weibull parameters at the height of 51 m

Wind direction rose and wind power rose at the height of 50 m are presented in Figure 3. Wind direction rose shows that a prevailing wind direction is from the South-East. Wind power distribution shows that the main part of the wind energy is from the South-East.

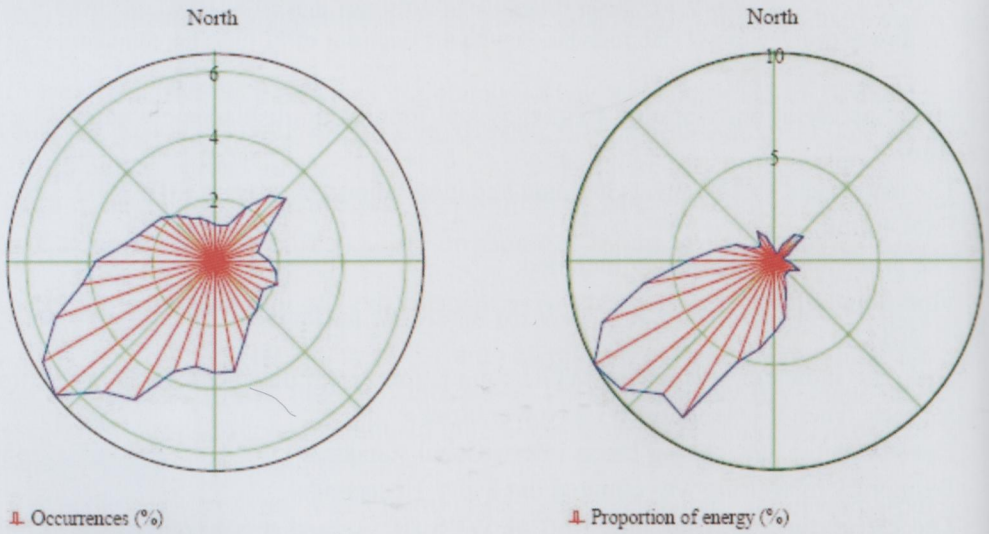


Figure 3 – Wind direction rose (left) and wind power rose (right)

According to the results of wind pressure measurements the diagram of seasonal distribution of wind speed was made. It demonstrates the changes in the wind flow speed by month in relation to average annual wind speed in Figure 4.

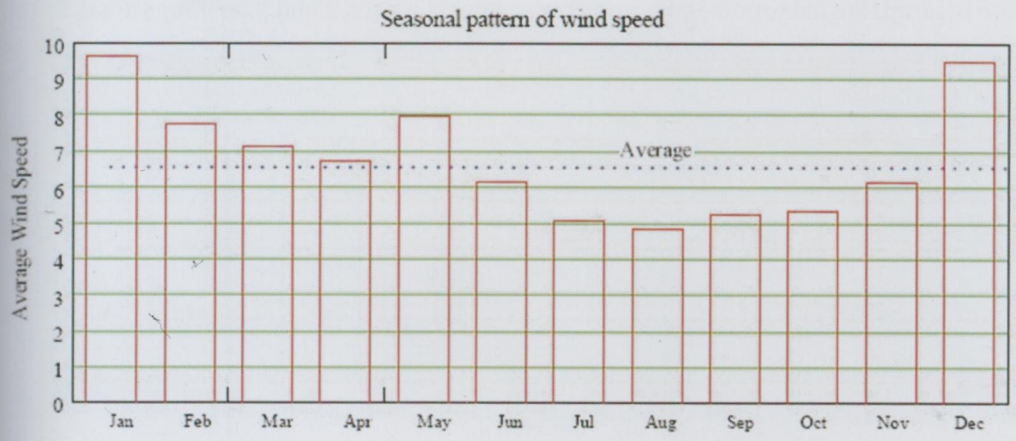


Figure 4 – Monthly average wind speed at the height of 50 m

Testing WPU foundation. Vibration effect of WPU foundation was tested at the site with the use of VIBRA Profound indicator. Before the measuring the vibration indicators are set on WGU foundation at the distance of 100 mm from the tower block to avoid a direct contact with the excitation source (the tower block) in Figure 5 (Zhussupbekov 2016).

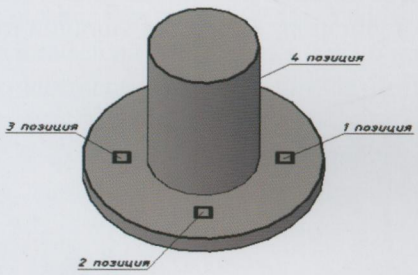


Figure 5 – Fixing a vibration indicator on WPU foundation

With the help of the instrument we got the diagram of dependence of foundation absolute displacements and the time in this area (Figure 6). The diagram shows the maximum values of displacements for each position. The maximum values of displacements for the 1 position

are 0.1 mm, the maximum values of displacements for the 2 and 3 positions are 0.2 mm, and 0.3 mm – for the 4 position, at the maximum wind pressure of 4.75 m/s.

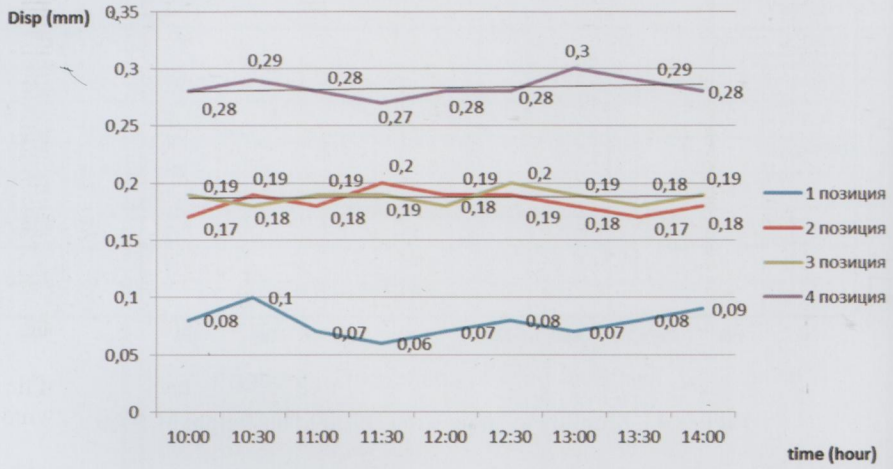


Figure 6 – Graph of dependence of displacement from to time

The second stage was the setting the vibration indicator on the excitation source (the tower block) of WPU.

The measurement results of vibration shown in the graphs of dependence of displacements, accelerations, frequencies of vibration, velocity of vibration from wind speed in Figure 7.

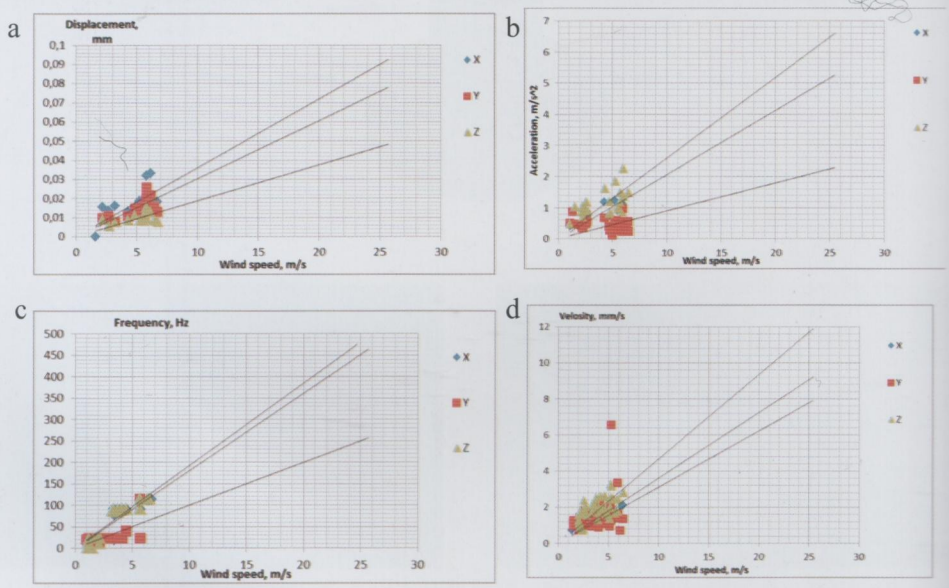


Figure 7 – Diagrams of dependence of displacements, accelerations, frequencies of vibration, velocity of vibration from wind speed: *a* – graphs of dependence of displacements from wind speed; *b* – graphs of dependence frequencies of vibration from wind speed; *c* – graphs of dependence of accelerations from wind speed; *d* – graphs of dependence of velocity of vibration from wind speed

a b

Figure 8 – The location and the sensor measurements of vibrations: *a* – the location of the sensor on the tower wind turbine; *b* – sensor readings maximum displacements of the tower wind turbine

Conclusions. According to the results the measurement was made the prediction of vibration parameters of the wind turbine foundation from wind pressure.

Maximum values of the parameters at the maximum wind pressure in this region are:

Maximum displacement on X=0,038 mm, Y=0,031 mm, Z=0,08 mm;

Maximum acceleration on X=2,8 m/s^2, Y=2,1 m/s^2, Z=0,7 m/s^2;

Maximum frequencies of vibration on X=122 Hz, Y=120 Hz, Z=65 Hz;

Maximum velocity of vibration on X=4,2 mm/s, Y=3,6 mm/s, Z=2,8 mm/s.

This parameter of displacements for wind turbine does not exceed the maximum permissible value of 5 mm (DIN 45669-1 1995).

The authors express their deep gratitude to the employees of Kazakh companies LLP "First wind power station" and LLP "KGS" for technical supporting of experimental research.

REFERENCES

1 National program of wind energy development until 2015 with the perspective till 2024 (project). (2007), Almaty/ /Astana, 3-5.

2 Technical Norms and Regulations 2.01.07-85*.(1987), Loads and effects, Moscow, 26–33.

3 DIN 45669-1. Human exposure to vibration in buildings. (1995-06), Germany, 8.

4 Zhussupbekov, A.Zh., Orazova, D.K. and R.E. Lukpanov. (2016), "The analysis of vibrational effect from the tower block to the foundation of the wind power unit (WPU) of Ereymentau wind power station (WPS)", Bishkek, **51**, 396–401 (by Russian).

Подписано в печать 11.12.2017 г.
Гарнитура Таймс. Формат 70x100 $^{1}/_{16}$.
Уч.-изд. л. 10,8. Тираж 1000 экз.

Отпечатано в типографии ТОО «Luxe Media Group»