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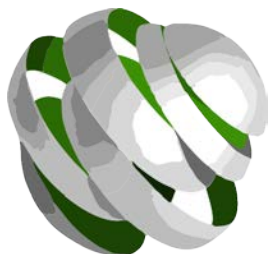
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CRITERIA FOR WIND ENERGY PROJECTS' LOCATION ASSESMENT

КРИТЕРИИ ЗА ПОДБОР НА ЛОКАЦИЯ НА ВЕТРОЕНЕРГИЙНИ ПРОЕКТИ

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Abstract: Insuring a sustainable development of wind energy production and consumption is challenging and highly important for achieving of EU 20/20/20 goals for Bulgaria. Wind energy has been seen as a clean and environmentally friendly in comparison with conventional energy sources, but there are still some conflicts between wind energy project development and environmental protection goals that should be enlighten and solved. One possible way is to enhance the process of wind energy projects' location identification. The current research is focused on identification and classification of criterion that could be used in this process. The legal requirements regarding wind energy projects' location are analyzed and presented. Additional requirements regarding environmental protection and biodiversity conservation are identified and defined as criterion. A set of measurable indicators related to each criteria is established and proposed in this paper.

Keywords: WIND ENERY PROJETS, LOCATION, CRITERIA, ENVIRONMENT

1. Introduction

The increasing renewable energy share in energy production and gross final energy consumption is a global sustainable trend. The Worldwide installed wind energy capacity shows 4.47-fold rise for the period from 2008 to 2017. The installed wind energy capacity in the European Union (EU28) increased from 63 865 MW in 2007 to 171 244 MW in 2018 year, which is nearly 2-fold rise. The same trend is observed in Bulgaria: the installed energy capacity in 2007 was estimated to 114 MW while in 2018 reaches 699 MW [7,17]. This impressive 6.13-fold growth is in line with the achievement of EU20/20/20 targets pointed out by the 2009/28EC Directive of the European Parliament on promotion of use of energy from renewable sources [6]. In the conditions of rapid and dynamic development of wind energy in our country appears the objective need of detailed review of the process of wind energy projects' disposition determination. Creation of methodology for potential wind energy projects' location assessment is an opportunity for sector's optimization and avoidance of conflicts in the "energetics-environment" interaction. The wind turbines' lifetime, estimated to 20-25 years, together with the eager of the investors to insure a definite internal rate of return, lead to the need of the WEPs location selection, based on long-term environmental alterations assessment [10]. Obviously the potential land use conflicts should be taken into consideration.

The present research aims to fill in some of the existing gaps in WEPs' disposition determination by proposing set of criteria applicable to WEP location assessment. The efforts are focused on criteria identification and classification, to support practitioners in WEP sector as well as decision makers.

2. Criteria for Wind energy projects potential location assesment

To achieve and maintain sustainable development of wind energy in Bulgaria is essential to balance the economic efficiency with social and environmental goals. In order to ensure long-term sustainability of WEP a set of criteria that fully covers the process of potential WEP location assessment and exact WEP disposition determination is required. The understanding of interaction and interdependence of economic, technical and environmental factors is a key precondition for WEP location assessment optimization.

The reassurance of renewable energy production with the purpose of insuring energy independence, deduction of greenhouse gas emissions and climate change combating is transposed by Directive 2009/28EC of the European Parliament on promotion of use of energy from renewable sources. This interaction already has a legal performance. The EU legislation related to wind energy as apart of renewable energy was transposed in the Bulgarian law for

energy by renewable sources at the end of 2011. Other regulations inforce correlate to environmental protection and agricultural territories' protection, urbanization and urban territories. Numerous restrictions regarding WEP development have been introduced in Bulgaria, such as:

- Prohibition of WEP construction closer than 500 meters from regulated territories under the law for servitudes;
- 35 meters minimum distance to forests;
- 200 meters minimum distance to protected forests;
- 100 meters minimum distance to lakes/rivers;
- Maximum 600sq.m of agricultural land for foundation construction and adjoined infrastructure.

The already existing restriction and prohibition by the Bulgarian law are out of the context of the present research. The existing regulation has an imperative character and only WEP territories with building permit are a subject of evaluation of proposed criteria.

To highlight the main proper conditions for WEP development on certain territory a set of criteria is propose. It includes three main groups of criteria: economic, technical and environmental. In Bulgarian practice many of the problems with WEPs' territorial disposition selection originate from the fact that the assessment process lay down only on economic analysis. A social-economic evaluation and assessment of the value of ecological assets is not performed at all. Thus, we adopt an analytical approach with defragmentation of criteria, so they specifically cover the economic, technical and environmental aspects. At the same time the practice requires more detailed and precise overview and assessments of the conditions under which the WEPs will be developed during the whole life-cycle of the project. That leads us to the detailysation of the proposed groups of criteria requirement. Thus, further decomposition of the main criteria is conducted and classification of criteria is presented on Fig.1. The proposed criteria are out of the specifically prohibited by the Bulgarian legislation restrictions. Three groups of interconnected criterion are definitively underlined: i) economic ii) technical and iii) environmental. The WEPs' location assessment requires analyses at least on the above-mentioned criteria and further synthesis. The evaluation of each criteria fulfillment demands observation, monitoring and analyzation of number of parameters.

The group of economic criteria, as proposed, includes: Wind potential; Initial cost; Maintenance cost; Preferential prices/feed in tariffs.

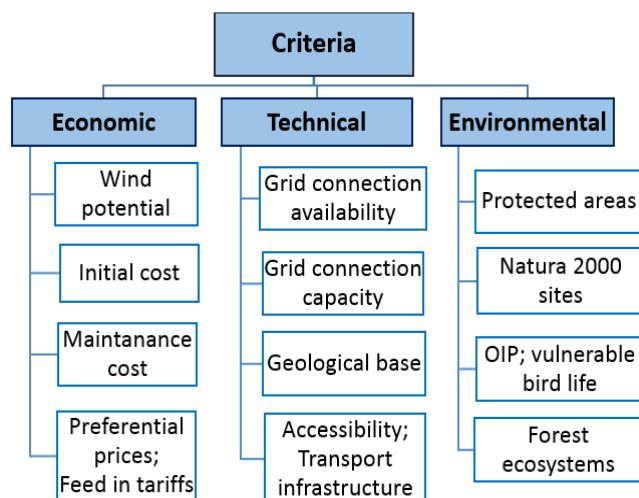


Fig. 1 Criteria for WEP location assesment and selection

Beneath “Wind potential” criterion achievement we recognize the presence of wind potential, meeting the qualitatively and quantitatively requirement. It is a predominant condition for WEP development on certain location. So, the vector realizations of the variables wind speed, velocity and density, compared to the defined minimum requirements for WEP development, manifests the level of criterion’s completeness.

“Initial cost” criterion accomplishment suppose that the initial investment, including project purchase fee, project development cost and equipment and construction price, is acceptable and admissible from the investor’s perspective. In order to assess the initial expenses on the project additional factors such as project grid connection fee should be evaluated too.

“Maintenance cost” comprises the annual wind project’s maintenance. The parameters of interests are operational costs, scheduled and unscheduled fees for reconstruction. The administrative burdens are considered in the frames of “Initial cost” and “Maintenance cost” criterion.

“Preferential prices or feed in tariffs” aims to feed the evaluate expecting internal rate of return (IRR) calculation. Another parameter with significant importance is the state guaranteed period for purchase of the produced energy.

The group of technical criteria is broken down to: Grid connection availability; Grid connection capacity; Geological base; Accessibility and transport infrastructure.

“Grid connection availability” stays to manifest the presence of electrical grid in the area of interest. This criterion alone is not equal to wind energy projects’ grid connectivity because the presence of grid does not guarantee the availability of capacity for connection and transfer of energy to the end consumer.

The “Grid connection capacity” is set as a criterion, comprising the presence of free grid capacity and connectivity allowance. The fulfilment of each of those criterion is necessary condition, but only simultaneously jointly achievement of both insure the grid connection of wind projects.

“Geological base” includes the possibility for foundation and installation of wind turbines which weight and base have to be precisely planned on appropriate Earth layers. The parameters of interests are stability of the base and predetermined ease of construction work.

“Accessibility and transport infrastructure” has a multiple means. From one side the WEP’s accessibility is crucial for its construction and is highly important for the project maintenance. The wind turbine elements are over-dimensions and require roads via which special vehicles can pass through. On the other side all

year round accessibility is needed for the annual maintenance which insures the WEP proper operation.

More parameters could be added to the proposed one but these are considered as the minimum required for the purpose of initial selection of wind project location.

Due to the fact that the economic and technical criteria are well known in practice the interest in the article turns upon the environmental one. The assessment of ecosystem services is an expensive, time taking and challenging task. That’s how easy the environmental protection goals and environmental responsibility of organizations drop back as criterion of WEP location determination process. The objective need of simple, clearly defined environmental criterion revealing the interconnection and interdependence between WEPs’ development and environmental protection is obvious.

The group of environmental criterion, as proposed, includes: Protected areas; Natura 2000 sites; OIP/vulnerable bird life; Forest ecosystems. The concerns regarding wildlife and natural habitats preservation are taken into consideration. While the economic and technical criteria simply a presence and preference, the environmental suggests absence or avoidance.

For the purposes of current classification the “Protected areas” criterion is fulfilled when the potential WEP location stays off-protected areas and buffer zones.

“Natura 2000 sites” require avoidance of NATURA protected areas as well as buffer zones around them. In accordance to Bulgarian practice we accept the minimal buffering range of 900 meters.

The Ornithology important places (OIP) spread over the marked and overlapped with Natura 2000 areas, the migration routes, especially the one with narrow migration front. No matters that OIP aren’t necessarily special protected areas, from investor’s perspective, those sites are risky especially when vulnerable bird species are in high abundance.

The high ecologic importance of the “Forest ecosystems” imposes their presence among the environmental criteria, no matter of their legislative status.

Environmental criteria cover the field of direct and indirect interaction between wind energy and environment.

3. Interaction between wind energy projects and environment in Bulgaria

No matter that wind energy is considered as relatively clean energy, with low water consumption [16], saving green gas house emissions there still are some conflicts between wind energy projects’ development and environmental protection goals that shouldn’t be neglected. Despite that Bulgaria takes less than 1% of European territory, the country is one of the EU member states with richness preserved biodiversity. Proclaimed sites for nature protection and preservation, excluding NATURA 2000 zones, are over 1000. The number of reservs with conservational significance counts to 90. General ban on WEP construction is imposed on-reserves..

Bulgaria obtains the second richest ornithological biodiversity in Europe [14]. It’s confirmed by the fact that 78% of the European common bird life including 12 globally endangered by extinction species are presented in Bulgaria [12, 13]. In this context our country is internationally responsible for the protection of vulnerable and threaten of extinction bird species.

In Bulgaria the number of wintering birds of European conservation concern exceeds 200 species [12, 11]. Among them is the Red- breasted goose (*Branta ruficollis*). Almost the whole world population winters in Kraymorska Dobrudzha. 114 ornithology important places (OIP) are appointed by Birth Life International in Bulgaria. In addition 118 Bulgarian sites (22.6% of the national

territory) are a part of the largest network of protected areas - Natura 2000. The map of NATURA 2000 protected zones is presented on Fig.2. These zones are established to ensure the long-term survival of Europe's most valuable and threatened species and habitats, listed under both the Birds Directive and the Habitats Directive. In Bulgaria the OIP and Natura 2000 sites generally are overlapping territories.

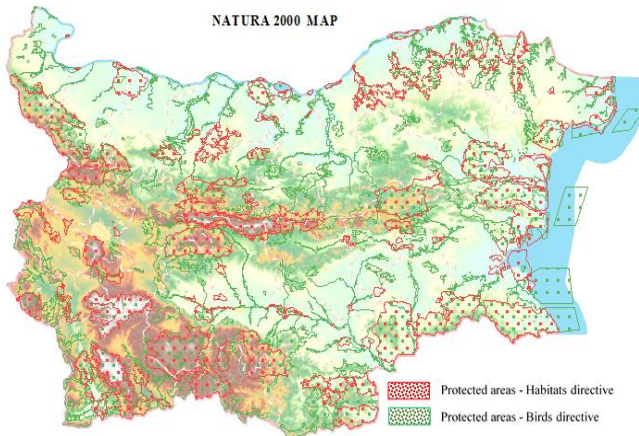


Fig. 2 Protected sites by NATURA 2000 in Bulgaria

The main birds' migration routes in Bulgaria are: *Via Balcanica*, *Via Aristotelis* and *Via Pontica*, which is the second largest migration route in Europe. *Via Pontica*, crosses the western Black Sea region via Bulgarian Black Sea coastline, entering up to 100km inland. Over 620 000 soaring birds traverse to South Africa via Bulgaria. Annually 78 % of the world population of white stork /*Ciconia ciconia*/, the whole Europe population of pink pelican /*Pelecanus onocrotalus*/ as well as 24 species threatened with extinction [12, 11]. The geographical migration regions division are presented on Fig. 3.



Fig.3 Migration regions on the territory of Bulgaria with studied sites [10]

In practice the interaction between WEP development and environment often results in land-use conflicts. The main reason is the territorial overlap between regions with high wind potential and high birds abundance.

For the period of 2003-2009 in Bulgaria 2840 applications for wind energy installations are presented in the Regional inspections of environment. 83 % of them are realized without evaluation of the environmental impact (EEI). [9, 2] Most of the applications are for single wind generators or for less than 7 wind generators in a farm which is used EEI to be avoided. This is one of the flaws which the Ministry of environment found in the procedures. Using this

disadvantage some investors administratively "transforms" their large- scale project into small- scale projects [11, 10].

Till August 2015, 3233 are the applied wind generator investor intends only on the territory of Regional inspection for protection the environment – Varna. The realized intends are 401, 245 of which are located in protected zones [15]. Despite the EU court practice for not allowing disturbance of habitat or anxiety in OIP, in Bulgaria after its acceptance as a EU member state, construction of wind farms in IOP and in Kaliakra /Dobrudzha/ was allowed [11, 20].

The Ministry of Environment and Water already accepted some legislative prohibition and provisional restriction due to WEP permission for construction in some areas as Dobrudzha, East Rodophy maintain and Bourgas region purposing protection and minimizing the risk for sensitive to wind generators bird species. Temporal and permanent restrictions regarding WEPs construction are in force for numerous individual NATURA sites, showed on figure 4 in purple. The blue markings corresponding to the areas with mean wind speed over 4m/s.

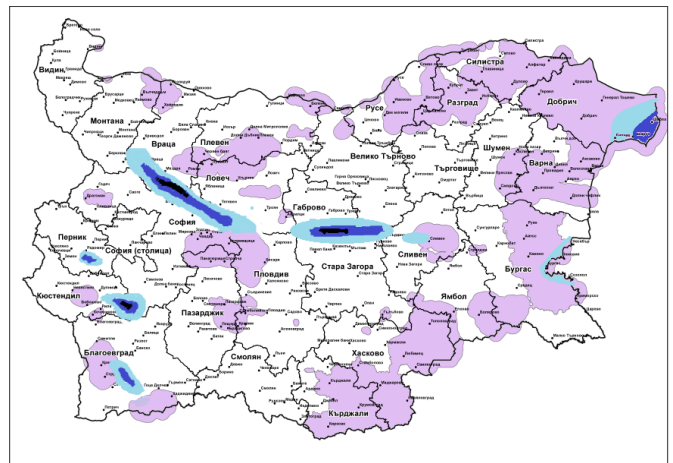


Fig. 4 Map of restrictions on WEP construction territories and wind potential map[11]

The WEPs development is put in disadvantaged situation in Bulgaria by the legislative acts of this kind. At the same time the world practice without doubt proves that encouraging investors to introduce and implement environmentally responsible approach in WEP development is a step in the right direction.

4. Conclusion

The proposed set of criterion and classification does not claim to be exhaustive. It represents an open flexible system, applicable to wind energy projects development, supporting the decision makers in the initial phase of WEPs' potential location assessment and disposition selection. The differences of national legislative requirements regarding WEP development easily can be introduced to the proposed classification.

The implementation of so classified criterion offers to the practitioners a wider perspective allowing them to take into account the full scale of aspects regarding WEPs' disposition and to balance economic and environmental demands and sustainability of the project. The complex achievement of the set of criteria could be evaluated properly only as a dynamic equilibrium, taking into account the use and non-use value of the nature, vulnerability of the assets and the overall added value of project.

The creation of methodology for WEPs' location assessment, based on proposed set of criteria is a subject of team future work.

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USE OF WILD-RAW RAW MATERIALS OF THE KR TO DEVELOP NEW FOOD PRODUCTS WITH INCREASED BIOLOGICAL VALUE

ИСПОЛЬЗОВАНИЕ ДИКОРАСТУЩЕГО СЫРЬЯ КР ДЛЯ РАЗРАБОТКИ НОВЫХ ПРОДУКТОВ ПИТАНИЯ С ПОВЫШЕННОЙ БИОЛОГИЧЕСКОЙ ЦЕННОСТЬЮ

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Faculty of Technology ^{1,3}, - Kyrgyz State Technical University after I. Razzakov, School of Tourism and Hotel Management ² - Kyrgyz
Turkman Manas University, Kyrgyzstan, Project for development of rural business with forest products in the Kyrgyz Republic, HIT Япония.

Abstract: *The article discusses the problems of nutrition, the impact on the human body and the ways of nutrition correction through the development of new products with high biological value from wild-growing raw materials of Kyrgyzstan. The possibilities of using wild fruits and berries and their complex processing are shown.*

KEYWORDS: FOOD, A WILD RAW MATERIAL, BIOLOGICALLY ACTIVE SUBSTANCES, EXTRACTS, HAW, GELATINE AND DRINK

1. Introduction

The past century, especially the second half, was marked by an unprecedented rate of enrichment of a person with new knowledge, which entailed everything that is called scientific and technical progress. The rapidly changing modern civilization, with its colossal possibilities in any field of human activity, has generated and still unprecedented pollution of the human habitat, since human development has taken the anthropogenic and nature-destructive path. Air, water and food are over-saturated with industrial and transport waste (including carcinogenic and mutagenic benzo (a) pyrene, heavy metals, radionuclides, etc.), pesticides, antibiotics, mycotoxins and other numerous xenobiotics. The consequence of this is the deterioration of the so-called "endoeology" of human and the widespread increase in environmentally determined diseases and mortality from them.

In the Kyrgyz Republic, the negative dynamics in the state of health of the population is more pronounced due to the economic, social crisis that continues today, and entails a deficit in the nutritional structure of vital macro and micronutrients that can enhance the adaptive functions of the body.

The emergence and development of many nutritionally-related diseases are associated with the quality of nutrition. The solution to this problem is the large-scale industrial production of so-called "healthy" food products, raised to the rank of a state program. The first step in the

implementation of this program should be the development of scientific approaches to the creation of new generation food products containing biologically active substances with protective, regulatory and therapeutic effects.

Food, as it is known, is a complex containing many precursors of biologically active substances, of which New biologically active substances are created in the body: hormones, transmitters, enzymes, biomolecules (DNA, RNA), and other structural elements of the living body.

Being one of the most important factors determining the health of the population, a complete, balanced, rational, age-appropriate, professional activity, living conditions, and state of health largely determines not only the health of children and adults, but is also an important element in the prevention of many common chronic diseases, including cardiovascular, oncological, gastrointestinal, endocrine, increases efficiency and creates the conditions for adequate adaptation of the organism to adverse factors of the environment. Water, air, food raw materials and food products contain an increased number of radionuclides, highly toxic chemical compounds, biological agents, pesticides, industrial and transport waste, nitrates and nitrites, mycotoxins, antibiotics, etc., which contributes to the growth of negative trends in the health of the population, reduce the well-being of people in almost all continents and states.

Food partially or completely ceased to have medicinal properties, to satisfy the human body in the daily required food nutrients in accordance

with physiological needs. According to the WHO, 80-95% of the substances alien to humans come with food, 4-7% with drinking water, 1-2% of the atmospheric air through the skin of the body into the adjacent tissues [1].

Another objective reason for the decline in human health, especially in economically developed countries of the world, is the widespread use of industrial products that have undergone tough technological processing, canning, and refining, which leads to almost complete and partial degradation of natural biologically active compounds - vitamins, minerals, phytosterols, nucleotides and other bioregulators of metabolism. This in turn leads to immunodeficiency, reduced mental and physical performance, exacerbation of chronic diseases [2].

Kyrgyzstan is among the first in terms of incidence and mortality from stroke. Distortions in the nutritional structure of the population of our country, the use of poor-quality and often counterfeit products affect the body's ability to withstand environmental aggression, hence its health, especially the health of children.

2. Background to solve the problem

Indirect evidence of serious problems with food, the quality of food consumed in the Kyrgyz Republic is not only a decline in the physical development and health of children of all age groups, but also the continued growth of diseases of the adult population of the country in such nosology groups as cardiovascular, cancer, and metabolic diseases and etc.

In the Kyrgyz Republic, if in 2015 the energy value of the diet (2212 kcal / day) of the population as a whole and its working part was higher than the minimum consumption rate (2101 kcal / day) (approved by the Government of the Kyrgyz Republic (November 6, 2009 No. 694)), then 2017 there was a decrease by 5.1% and 0.2%, compared with data from 2015 (2097 kcal / day) and the minimum consumption rate (2101 kcal / day), respectively. According to research results, it is clear that almost all these years there has been

an insufficient consumption of proteins (meat, dairy products and legumes) and fats (vegetable oils) on average by 23.3% and 16.9%, respectively [2].

Energy demand of the population is filled by flour and confectionery (sugar) products and potatoes, since the majority of people in the Kyrgyz Republic (74% of the total population, 76.7% of men and 71.1% of women) consume less than 5 servings of vegetables and fruits per day (MOH KR, WHO, 2013) with the recommended 5-9 servings (on average at least 400 g / s).

Of great concern is the lack of nutrition among children. So, in the diet of the child population (1-17 years) during 2015-2017. there was a pronounced shortage of not only protein (by 27.5%) and fat (by 22.7%), but also energy value (by 2.5-2.8%). In children aged 1-3 years, the lack of proteins (by 46.8-45.2%), fat (by 44.1-40.7%) is almost half, and the deficit of kilocalories (by 26.1-22, 5%) - one fourth of the minimum need for them per day [3].

According to the Ministry of Health's research, there is a high prevalence of iron deficiency anemia among the population of the Kyrgyz Republic (37.8% of pregnant women and 34.2% of non-pregnant women, 42.6% of children), latent iron deficiency (41% of women), folate deficiency (42% of non-pregnant women), iodine deficiency disorders (61.6% of pregnant women and 43.1% of children of school age), obesity overweight (35.7% of women and 9% of children of the first 5 years of age), underweight (7, 3% of women and 18% of girls 15-19 years) [4].

Another important problem for citizens of the Kyrgyz Republic related to nutritional deficiencies is the high content of transgenic fatty acids and salt in the food products of the population of the Kyrgyz Republic. The development of overweight and obesity, diseases of the heart and blood vessels (high blood pressure, heart attack, stroke, etc.), type 2 diabetes, and some forms of malignant tumors are associated with excess ingestion of transgenic fatty acids into the human body. In the

Kyrgyz Republic, for several years, heart and vascular diseases continue to occupy the first place in the structure of causes of mortality of the population (50.5%, RMRC).

In rural areas in Kyrgyzstan, more than 60% of families are unable to provide the minimum physiological need of children for basic foodstuffs, which is a threat to the preservation of the gene pool of the nation.

In terms of social groups (in terms of income), the most disadvantaged nutritional situation was among the citizens of the first quintile group (1 million 252 442 thousand people), who did not receive kilocalories, proteins and fats in the prescribed amount. Nutrition above the established level in all three estimated indicators is obtained only by citizens from the fifth, most wealthy quintile group (1 million 250 448 thousand people) [5].

Socio-economic shocks, the deterioration of the material well-being of the majority of the population, together with psychosocial and climatic-geographical factors, led to the growth of such diseases as anemia, iodine deficiency, malnutrition, and dystrophy of children and adults. In this case, the first thing need is treatment with proper nutrition.

Accumulated international experience suggests that it is almost impossible, due to economic, social and other factors, to achieve a rapid correction of the nutritional structure due to increasing the production of common types of food, as well as improving its quality and safety in traditional ways [6].

3. *Experimental part*

In these conditions, the most effective, reasonable and economically acceptable way to solve this problem is the creation and expansion of food products with high biological value.

The use of wild-growing fruits and berries as food with a high biological value makes it possible, on the one hand, to quickly and easily

eliminate the deficiency of essential nutrients that have a regulating effect on the organism as a whole or on certain systems, organs or functions, and on the other, to increase non-specific resistance of the organism to the effects of adverse environmental factors, to maintain a beneficial microflora in the human body, to reduce the risk of developing long-term effects of the environment [7].

For the prevention and correction of nutrition, we propose the use of wild-growing raw materials, which are not widely in demand, but at the same time are most important for maintaining human health and developing new foods with high biological value, natural foods made from environmentally friendly wild-growing raw materials, growing on the territory of our republic.

The main advantage of new types of food is 100% use of natural valuable types of raw materials with a high content of biologically active substances and multifunctional therapeutic and prophylactic properties. The basis of the selection of food models with a high biologically active value is the state of public health (reduced immunity, impaired functional activity of the gastrointestinal tract, cardiovascular system, atherosclerosis, arthritis, etc.), as well as the requirements of good flavoring and high biological value, balancing the nutritional value of foods according to the formula of nutrition in a quality set [8].

Blood red hawthorn is an additional raw material resource for the processing industry. When hawthorn fruits are combined with cultural fruits and berries, a product of better taste, aroma, color is obtained than products obtained from some varieties, which allows expanding the assortment of the products. According to the Department of Forestry of the Kyrgyz Republic, 130 species of wild fruits and berries grow in the south part of the country, which occupy 603 hectares of land. The annual collection of wild fruits and berries amounts to 5,000 tons. Among them the great interest is the blood-red hawthorn. Due to varietal characteristics, hawthorn is not used in the food industry.

The main purpose of the work is to develop optimal modes of extracting blood-red hawthorn, with the aim of further using the extract in the production of food with high biological value (drinks and jelly).

Extraction of blood-red hawthorn was carried out in experimental conditions in reactors with a stirrer on the basis of JSC "Bailyk".

Extraction was carried out in two staged direct-flow method, with different margins and water ratios, and different temperature conditions. The obtained extracts were subjected to chemical analysis.

The modes in which the largest amount of biologically active substances passes into the extract and in which no color changes occur, the taste of the extract, and which do not lead to difficulties in carrying out technological processes were chosen as the optimal temperature regimes of extraction.

To extract the fruits, the blood red hawthorn was blanched at a temperature of 80-90 ° C with live steam for 3-5 minutes, then wiped with a single-stage wiping machine. Primary marc after obtaining puree, poured water was extracted at a temperature of 750 ° C for 30 minutes. The ratio of water and marc: 2:1.

The obtained primary extract was reused to extract secondary marc under the same conditions. The chemical composition of the raw material of blood-red hawthorn and secondary extract was studied. The results are listed in table 1.

Table 1

Analysis of the chemical composition of blood-red hawthorn and secondary extract

Name of raw materials Indicators		Blood-red hawthorn	Secondary extract of blood-red hawthorn
Dry matters, %		22,2	7,84
Carbohydrates, %	Total	15,40	6,30
	Mono and disah	12,00	5,54
	Sucrose	3,40	0,76
Organic acids, %		0,60	0,31
Vitamin C mg%		89,00	12,2
Pectic substances, %		3,66	3,08
Cellulose, %		1,78	2,32

In these conditions, the most effective, reasonable and economically acceptable way to solve this problem is the creation and expansion of food products with high biological value.

The chemical composition of the extracts obtained according to the above regimes shows that mono and disaccharides, pectic substances are contained in the greatest quantity.

The content of a large amount of pectic substances in the extract is due to the fact that hawthorn fruits are subjected to heat treatment, which leads to an increase in soluble pectin. Pectic substances are very important matrix polysaccharides. Pectic acids are very easily extracted with water and are capable of forming gels. This ability in this work we use in the production of marmalade from secondary extracts.

A significant decrease in the sucrose content is due to the fact that in the process of extraction, obviously, under the influence of high temperature, sucrose is inverted to monosaccharides.

The mineral composition of the secondary extract of the blood-red hawthorn extract was also studied.

Table 2

The mineral composition of the secondary extract of the blood-red hawthorn

Name of studied raw material		Blood-red hawthorn (second extraction)
The content of macro and micronutrients: mg% per 100 g of product	Na	11,74
	R	178,2
	Ca	10,24
	Mg	8,99
	P	7,79
	Fe	0,74

From table 2 it can be seen that the mineral composition of the secondary extracts is also rich.

Residues from secondary extraction mainly contain fiber. From the recently published WHO data on the relationship between the nutritional status of the population in economically developed countries and mortality from cardiovascular diseases, it follows that there is a clear negative correlation between the latter and

the level of fiber intake and positive - with the total caloric intake and also with the consumption of food of animal origin. Given these properties of dietary fiber, squeezing hawthorn after secondary extraction is used for the production of dietary fiber.

4. Conclusion

Thus, studies on the study of secondary extracts from blood-red hawthorn, as a basis for creating new products with high biological value, show that:

- the obtained extracts contain a sufficiently high amount of biologically active substances;
- due to the biological value, the obtained extracts can be used for the production of diffusion drinks, jelly, marmalade;
- residual squeeze after secondary extraction, mainly contain fiber, and their use for the production of dietary fiber is possible;

From the obtained secondary extracts, a technology and formulation for obtaining diffusion drinks and marmalade have been developed.

Conclusion:

- experimental data obtained confirm the feasibility of using blood-red hawthorn as an object for obtaining food products;
- justified and obtained a number of relationships that allow at the stage of preliminary research and practical implementation of the production of beverages, jellies, the necessary rational parameters of extraction modes.
- the results of various extraction methods were studied and summarized, the optimal ones were chosen.

- blood-red hawthorn husks are a rich source of pectic substances, and can be used to obtain food semi-finished products used in the canning and confectionery industry.

Thus, the blood-red hawthorn is an effective source of biologically active substances, most of which are extracted from the pomace with water, under certain optimal conditions, and can serve as an additional raw material for obtaining new foods with high biological value.

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PHYSICAL AND LUMINESCENT PROPERTIES OF GLASSES IN THE SYSTEM WO₃-La₂O₃-B₂O₃-Nb₂O₅

ФИЗИЧНИ И ЛУМИНЕСЦЕНТНИ СВОЙСТВА НА СТЪКЛА ОТ СИСТЕМАТА WO₃-La₂O₃-B₂O₃-Nb₂O₅

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Abstract: New multicomponent glasses in the system WO₃-La₂O₃-B₂O₃-Nb₂O₅ doped with Eu³⁺, as a transparent active media for optical application were obtained. Physical parameters as density, molar volume, oxygen molar volume and oxygen packing density were determined. The thermal behavior of the obtained glasses was examined by differential thermal analysis (DTA). It was established that glass crystallization temperature is about 750°C. Microstructural characterization was made by Raman and UV-VIS spectroscopies. Based on the obtained spectral data short-range order and connectivity in glass network were determined. High photoluminescence emissions due to the 4f transitions ⁵D₀→⁷F_j (j=0-4) of Eu³⁺ ions were observed. Colorless bulk tungstate glass, containing Nb₂O₅ with high transparency and high refractive index were prepared.

KEYWORDS: GLASS, DENSITY, REFRACTIVE INDEX, RAMAN SPECTROSCOPY

1. Introduction

Glasses belong to advanced functional materials. Their properties (electrical, optical) depend significantly on the local structure of the glass. Thus, the luminescence properties of rare earth elements depend largely from the matrix in which they are doped.

The tungsten and niobium oxide based glasses are suitable for optical applications, as well suitable matrices for doping with active ions possessing characteristic emission in the visible area [1-3].

Eu³⁺ ion is the most popular and important active ion for obtaining intensive red emission. The emission intensity of europium (III) ion embedded in tungstate phases is prominently enhanced (compared with that of Eu³⁺ in the most hosts) because of the non - radiative energy transfer from the WO₄ group in the host matrix to the rare earth ion. Moreover, in Eu³⁺ doped tungstates, pure red color can be obtained due to the distortion of the local symmetry of Eu³⁺ ion in the host. As a result, tungstate glasses can serve as competitive host materials in the optical field. On the other hand Nb₂O₅-based glasses exhibit excellent optical properties exceeding those of commercial optical glasses. These glasses show a wide optical transparency in the visible to IR range and have a high refractive index (over 2.1) in the visible region with low wavelength dispersion.

Our experience in synthesis and structural investigations of tungstate glasses motivates us to examine the possibility of synthesis of tungstate glass with participation of Nb₂O₅ and to establish its influence on physical, structural and luminescent properties of Eu³⁺ added in the glass matrices.

For the initial tungstate glass, 50WO₃:25La₂O₃:25B₂O₃ composition was chosen whose structure and physical properties were established in our previous studies [4-6].

2. Experimental

Samples with the compositions: 50WO₃:25La₂O₃:25B₂O₃ (WLB); 40WO₃:25La₂O₃:25B₂O₃:10Nb₂O₅ (WLBN); 50WO₃:22La₂O₃:25B₂O₃:3Eu₂O₃ (WLBE); and 40WO₃:10Nb₂O₅:22La₂O₃:25B₂O₃:3Eu₂O₃ (WLBNE) (mol%) were prepared using reagent grade Nb₂O₅, H₃BO₃, La₂O₃ WO₃ and Eu₂O₃. The batches (each batch weight: 20 g) were melted at 1250–1280 °C for 30 min in a platinum crucible in air. The glasses were obtained by pouring the melts onto an iron plate and by pressing with another iron plate (cooling rate: ~10² K/s). Density of the glasses at room temperature was determined with the Archimedes method using distilled water as an immersion liquid. The glass transition (T_g) and crystallization (T_p) temperatures were established by differential thermal analyses (DTA) (RigakuThermo

Plus TG 8120) at a heating rate of 10 K/min (±1 K). Optical transmission spectra were measured in the wavelength (λ) range of 300–1000 nm at room temperature using a spectrometer (Shimadzu U-3120). The uncertainty in the observed wavelength is about ± 1 nm. The optical energy gap (E_{opt}) of glasses was calculated from the transmittance spectrum using Tauc plot road and following equation:

$$\alpha h\nu = A(h\nu - E_{opt})^2 \dots \dots \dots (1)$$

where α is the absorption coefficient, h is the constant of Planck, ν is the frequency of light and A is the energy constant.

Refractive indices at a wavelength (λ) of 632.8 nm (He-Ne laser) were measured at room temperature with a prism coupler (Metricron Model 2010). Raman scattering spectra at room temperature were measured with a laser microscope (Tokyo Instruments Co., Nanofinder) operated at Ar⁺ (λ = 488 nm) laser with resolution of ±1 cm⁻¹. The photoluminescence (PL) spectra of 50WO₃:22La₂O₃:25B₂O₃:3Eu₂O₃ and 40WO₃:10Nb₂O₅:22La₂O₃:25B₂O₃:3Eu₂O₃ glasses in the visible region of Eu³⁺ ions for the glass samples were measured with a PL spectrometer (Hamamatsu Photonics: C9920-20) at room temperature, in which the excitation light with a wavelength of λ = 397 nm was used.

3. Results and Discussion

3. 1. Glass formation

Homogeneous transparent glasses were obtained from the all compositions studied. Figure 1 presents pictures of 50WO₃:25B₂O₃:25La₂O₃ and 40WO₃:25La₂O₃:25B₂O₃:10Nb₂O₅ (WLBN) glasses. In order to polish the glass samples, they were heat treated at temperature, which is 10 °C below the glass transition temperature for the relaxation from the internal stresses. Despite this, the Nb₂O₅ - free glass, cracked and broke into small pieces. This result shoes that desirable sized bulk sample can be obtained from the Nb₂O₅ - containing composition only.

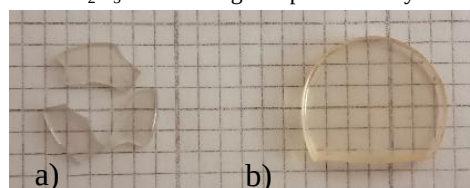


Fig. 1. Pictures of a) 50WO₃:25B₂O₃:25La₂O₃ (WLB) glass; b) 40WO₃:25La₂O₃:25B₂O₃:10Nb₂O₅ (WLBN) glass

Obviously, the presence of Nb_2O_5 , increases the glass forming ability and stability of the samples which is important from the technological point of view.

3. 2. Physical properties

The simplest way of detecting structural changes in glass network, with compositional variation is by probing its rigidity/flexibility by measuring the glass density and calculating of molar volume, oxygen molar volume and oxygen packing density of the glass system [7, 8]. Having in mind this, we measured the density of the obtained multicomponent glass containing 10 mol% Nb_2O_5 (WBLN) and compared with the density of the $50\text{WO}_3\cdot 25\text{B}_2\text{O}_3\cdot 25\text{La}_2\text{O}_3$ (WBL) glass previously reported by us in ref [6] in order to check the effect of the Nb_2O_5 on the physical properties and structure of the ternary tungstate glass.

The density of glasses was estimated according to the Archimedes principle by using the equation:

$$\rho_g = \frac{W_a}{W_a - W_b} \times \rho_o \quad (2)$$

where, W_a is the sample weight in air, W_b is the sample weight in the water, ρ_o is the density of the water. Theoretical density of glasses was calculated by the following equation

$$\rho_{th} = \frac{\sum x_i \rho_i}{\sum n_i} \quad (3)$$

where, ρ_i is the density of i^{th} oxide component and x_i is its mole fraction in the composition. From the experimentally evaluated density values the molar volume (V_m), the molar volume of oxygen (V_o) (volume of glass in which 1 mol of oxygen is contained) and the oxygen packing density (OPD) of $50\text{WO}_3\cdot 25\text{B}_2\text{O}_3\cdot 25\text{La}_2\text{O}_3$ and $40\text{WO}_3\cdot 25\text{La}_2\text{O}_3\cdot 25\text{B}_2\text{O}_3\cdot 10\text{Nb}_2\text{O}_5$ glasses were estimated, using the following relations respectively:

$$V_m = \frac{\sum x_i M_i}{\rho_g} \quad (4)$$

$$V_o = V_m \times \left(\frac{1}{\sum x_i n_i} \right) \quad (5)$$

$$\text{OPD} = 1000 \times C \times \left(\frac{\rho_g}{M} \right) \quad (6)$$

where x_i is the molar fraction of each component i , M_i the molecular weight, ρ_g the glass density and n_i is the number of oxygen atoms in each oxide, C is the number of oxygen per formula units, and M is the total molecular weight of the glass compositions. The values obtained are listed in the Table 1.

Table 1. Molecular weight M_w , theoretical density ρ_{th} , measured density ρ_{exp} , molar volume V_m , oxygen molar volume V_o , oxygen packing density OPD

Sample ID	M_w g/mol	ρ_{th} g/cm ³	ρ_{exp} g/cm ³	V_m cm ³ /mol	V_o cm ³ /mol	OPD mol/L
WLB	214.78	5.85	5.614	38.26	12.75	78.42
WBLN	218.17	5.59	5.503	39.65	12.39	80.72

As it is seen from the table, the experimentally evaluated density and the density estimated through formula compositions are comparable. It was found that the density decreases, while the molar volume increases with the introduction of Nb_2O_5 into a $50\text{WO}_3\cdot 25\text{La}_2\text{O}_3\cdot 25\text{B}_2\text{O}_3$ glass. These changes could be related to the incorporation of voluminous NbO_6 octahedra in the glass network resulting in its expanding. Compared to the ternary tungstate glass, a slight decrease in oxygen molar volume of Nb_2O_5 - containing glass, is detected due to the substitutions of higher field intensity W^{6+} ions (1.58) with lower field intensity Nb^{5+} ions (1.26) [9]. OPD value of $40\text{WO}_3\cdot 25\text{La}_2\text{O}_3\cdot 25\text{B}_2\text{O}_3\cdot 10\text{Nb}_2\text{O}_5$ glass is higher as compared with that of $50\text{WO}_3\cdot 25\text{La}_2\text{O}_3\cdot 25\text{B}_2\text{O}_3$ glass that can be attributed to an increasing network connectivity due to the

formation of new linkages between NbO_6 and the other structural units, existing in the amorphous network.

3. 3. Thermal analysis

In order to check the influence of Nb_2O_5 on the thermal behavior and structural features of $50\text{WO}_3\cdot 25\text{La}_2\text{O}_3\cdot 25\text{B}_2\text{O}_3$ glass, we have studied $40\text{WO}_3\cdot 25\text{La}_2\text{O}_3\cdot 25\text{B}_2\text{O}_3\cdot 10\text{Nb}_2\text{O}_5$ by DTA. DTA analysis is a useful method in suggesting structural change that take place due to the compositional changes [10]. The glass-transition temperature T_g gives information on both the strenght of inter atomic bonds and the glass network connectivity. The higher T_g corresponds to more rigid structure, whereas the glasses having a loose-packed structure have lower T_g [8, 11]. The difference $\Delta T = T_p - T_x$, between crystallization temperatures of the glasses (T_p) and glass transition temperature (T_g) has been frequently used as a rough measure of the glass thermal stability [12]. The higher ΔT value, the more favored is the glass forming process [13]. Fig. 2 compares DTA curves of $40\text{WO}_3\cdot 25\text{La}_2\text{O}_3\cdot 25\text{B}_2\text{O}_3\cdot 10\text{Nb}_2\text{O}_5$ glass investigated in this work and of $50\text{WO}_3\cdot 25\text{La}_2\text{O}_3\cdot 25\text{B}_2\text{O}_3$ glass previously studied by us [6]. The hump, corresponding to the glass transition temperature (T_g) followed by exothermic effects connected with the crystallization temperatures of the glasses (T_p) are clearly observed. Their values and the calculated thermal stability $\Delta T = T_p - T_x$ are listed in Table 2.

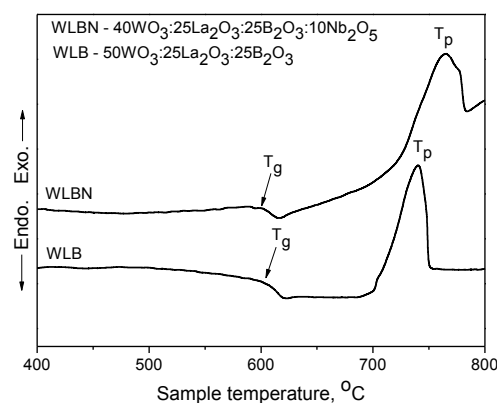


Fig. 2. DTA curves of $50\text{WO}_3\cdot 25\text{La}_2\text{O}_3\cdot 25\text{B}_2\text{O}_3$ (WLB) and $40\text{WO}_3\cdot 25\text{La}_2\text{O}_3\cdot 25\text{B}_2\text{O}_3\cdot 10\text{Nb}_2\text{O}_5$ (WBLN) glasses

Table 2. Values of glass transition temperature T_g , crystallization temperatures (T_p), thermal stability ΔT and average single-bond enthalpy E_B of investigated glasses.

Sample ID	T_g (°C)	T_p (°C)	ΔT (°C)	E_B kJ mol ⁻¹
WLB	598	745	147	727.75
WBLN	594	762	168	737.75

As one can see, both glasses are characterized with high values of the glass transition temperature (T_g), which is an indication of the formation of well packed glass structure. The addition of Nb_2O_5 does not affect significantly the amorphous network of the ternary $50\text{WO}_3\cdot 25\text{La}_2\text{O}_3\cdot 25\text{B}_2\text{O}_3$ glass as both glasses possess the same T_g values.

The values of T_g were correlated with average single bond enthalpy of glasses using the following relationship proposed in the ref [14, 15]:

$$E_B = \frac{50E_{W-O} + 25E_{La-O} + 25E_{B-O}}{100} \quad (7)$$

$$E_B = \frac{10E_{Nb-O} + 40E_{W-O} + 25E_{La-O} + 25E_{B-O}}{100} \quad (8)$$

where E_{W-O} , E_{B-O} , E_{La-O} and E_{Nb-O} are the bond dissociation energies for the single bonds: W-O; B-O, La-O and Nb-O respectively [16].

Having in mind that glass transition temperature is very sensitive to any change in the coordinating number of network forming atoms and to the formation of non-bridging oxygens [17-19] we can explained the equal T_g of both glasses as a result of the

replacement of WO_6 octahedral units by NbO_6 octahedra. The higher E_B value of the Nb_2O_5 -containing glass can be connected with the difference in bond dissociation energies of metal oxide. Since Nb-O bond enthalpy is 753 kJ mol^{-1} , which is higher than W-O bond enthalpy (653 kJ mol^{-1}), the average single bond energy increases with the addition of niobium, because of the formation of stronger Nb-O at the expense of weaker W-O bonds.

The thermal stability criterion ΔT of Nb_2O_5 -containing glass is larger indicating that Nb_2O_5 contribute to increase the thermal stability and glass forming ability of the composition.

3. 4. Raman analysis

Raman spectroscopy was used to deduce structural features of the obtained multicomponent glass containing 10 mol% Nb_2O_5 . A comparison was made with the Raman spectrum of $50\text{WO}_3:25\text{B}_2\text{O}_3:25\text{La}_2\text{O}_3$ glass previously studied by us [4]. The deconvoluted Raman spectra of both glasses are shown on Figure 3. It is known that the Nb-O and W-O characteristic vibrations overlap and appear in the same frequency range of the spectra. The strong Raman bands at 850 and 950 cm^{-1} in the spectrum of $50\text{WO}_3:25\text{B}_2\text{O}_3:25\text{La}_2\text{O}_3$ (WLB) glass have been assigned to isolated $(\text{WO}_4)_2$ units. The formation of WO_6 units have been suggested due to the presence of the band at 980 cm^{-1} [4]. In the spectrum of $40\text{WO}_3:25\text{La}_2\text{O}_3:25\text{B}_2\text{O}_3:10\text{Nb}_2\text{O}_5$ (WLBN) glass a new band at 913 cm^{-1} appears, bands at 980 and 760 cm^{-1} disappear and intensity of band at 688 cm^{-1} increases with addition of Nb_2O_5 . All bands observed in the spectrum of Nb_2O_5 containing glass can be also related to vibration of Nb-O bonds except those at 954 and 1040 cm^{-1} , which are related with the symmetric stretching vibration (ν_1) of $(\text{WO}_4)_2$ and vibrations of BO_3 and BO_4 structural units respectively.

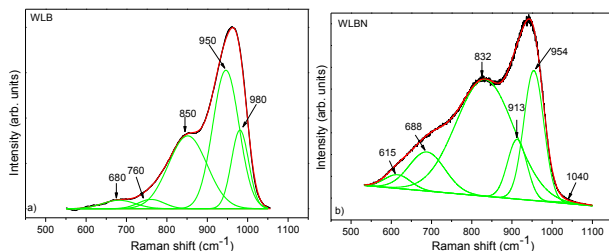


Fig. 3. Raman spectra of a) $50\text{WO}_3:25\text{B}_2\text{O}_3:25\text{La}_2\text{O}_3$ (WLB) and b) $40\text{WO}_3:25\text{La}_2\text{O}_3:25\text{B}_2\text{O}_3:10\text{Nb}_2\text{O}_5$ (WLBN) glasses.

The band at 913 cm^{-1} was attributed to short Nb-O bond in isolated NbO_6 units. The bands at 688 and 832 cm^{-1} can be associated with corner shared octahedra. [20-23]. Disappearance of the band at 980 cm^{-1} is probably a result of destruction of W-O-W linkages between WO_6 units and their transformation to WO_4 . Obviously Nb_2O_5 incorporates into amorphous network through W^{6+} forming new Nb-O-W bonds. NbO_6 polyhedra are mainly connected to each other by corner-sharing with vibrations in $800\text{--}600 \text{ cm}^{-1}$ range. Further investigations are needed to establish formation of Nb-O-La and Nb-O-B linkages because stretching vibration of these mixed bonds are in the same spectral range.

3. 5. Optical studies

The optical transmittance spectra of synthesized glasses are shown in Figure 4. The glasses are characterized with good transmittance reached to the 65-75 %. As one can see from the Fig. 4 the absorption edge of both glasses is around 350 nm. As the position of the absorption edge is related with the structural rearrangement and oxygen bonds strenght in the glass network [24], the absence of a noticeable shift in the position of the absorption edge with the introduction of Nb_2O_5 into tungstate glass evidenced that its presence does not change significantly the glass structure. This suggestion is also confirmed by the invariable value of the optical band gap energy E_g of both glasses determined from the optical transmittance spectra which is 3.5 eV. Having in mind these

results, we can suggest that Nb_2O_5 could have a role as a network former, replacing the tungstate structural units in the glass network as its presence does not reduce the E_g values of glass [25].

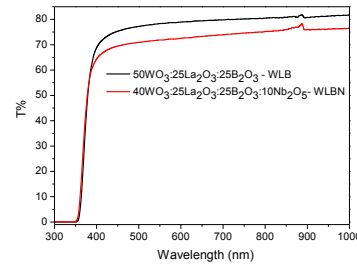


Fig. 4. Optical transmission spectra at room temperature of $50\text{WO}_3:25\text{La}_2\text{O}_3:25\text{B}_2\text{O}_3$ (WLB) and $40\text{WO}_3:25\text{La}_2\text{O}_3:25\text{B}_2\text{O}_3:10\text{Nb}_2\text{O}_5$ (WLBN) glasses

The refractive index (n) for the presented glasses is also established from the optical transmittance spectra. It is found that the refractive index of Nb_2O_5 -containing glass is higher (1.97844) as compared with that of Nb_2O_5 -free tungstate glass (1.97066) indicating the more densely packed structure in the presence of niobium [26].

3. 6. Photoluminescence spectra of Eu^{3+} ions

The PL spectra at room temperature for both glasses were measured and compared (Fig. 5).

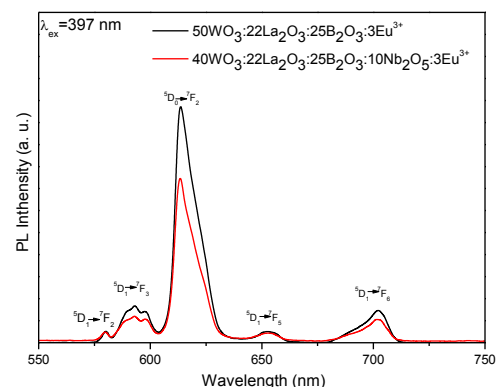


Fig. 5. Photoluminescence spectra at room temperature of Eu^{3+} ions in the range of 550–750 nm in $50\text{WO}_3:22\text{La}_2\text{O}_3:25\text{B}_2\text{O}_3:3\text{Eu}^{3+}$ (WLB) and $40\text{WO}_3:22\text{La}_2\text{O}_3:25\text{B}_2\text{O}_3:10\text{Nb}_2\text{O}_5:3\text{Eu}^{3+}$ (WLBNE) glasses.

The excitation light with wavelength of 397 nm was used. Five different emission peaks assigned to the $4f$ transition of Eu^{3+} ions, i.e., $^5\text{D}_0\text{--}^7\text{F}_j$ ($j=0, 1, 2, 3$ and 4) are observed. The peak intensity of the $^5\text{D}_0\text{--}^7\text{F}_2$ emission at 613 nm is much larger compared with the other ones. It is known that the $^5\text{D}_0\text{--}^7\text{F}_2$ emission band due to the electric-dipole transition largely depends on the local symmetry of coordination environments around Eu^{3+} [27]. High intensive peak of the $^5\text{D}_0\text{--}^7\text{F}_2$ emission indicates the Eu^{3+} occupies low symmetry site in the glass matrix. Nevertheless, that the addition of Nb_2O_5 slightly reduces the emission intensity of Eu^{3+} ions (Fig. 5), the improved glass forming ability and obtaining in a bulk form make Nb_2O_5 containing glass more appropriate material for different optical applications than Nb_2O_5 -free tungstate glass. It will be of interest to study the influence of the amount of Eu^{3+} ions on the luminescence properties of the compositions studied here.

4. Conclusions

It has been found that the addition of niobium to tungstate glass modify the structure of the amorphous network. New linkages between NbO_6 and the other structural units are formed increasing the degree of the network connectivity. In this way the addition of niobium even at low concentrations (10 mol%) to tungstate glass has a positive effect on glass forming ability as stabilizes the

amorphous network and increases thermal stability. The Nb₂O₅-containing glass is characterized with a high refractive index, which benefits for the potential optical applications.

Acknowledgments

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AMPLIFIED SPONTANEOUS EMISSION IN FIBER OPTIC LINES USING RAMAN AMPLIFIERS

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Abstract: New methods for a regeneration and an enhancement of the optical signal have been developed all over the world. The main reason is the increasing bit rate and optical fiber length. A new method for optical amplifiers based on nonlinear effects is discussed in this report. Amplification changes are surveyed as a function of the signal power at different pump configurations and different wavelength.

Keywords: Fiber Raman Amplifier (FRA), Amplified Spontaneous Emission (ASE), Optical noise, Raman amplification, Raman Gain Coefficient.

1. Introduction

Communication systems are used to transfer information both within a country, continent and for intercontinental transmission. Systems development and the growing information traffic require a new traffic area like fiber optic to be involved.

As nowadays Wavelength Division Multiplexing (WDM) systems are those with growing bit rate information and the length of fiber optic lines and use of repeaters leads to limitation of bandwidth, it is necessary to use another type of units to replace these devices.

Retransmission limitation also influences the transmission of information in modern multilateral (MLAT) systems that are increasingly used in radar-free areas. The limitations of the radio channels used in MLAT systems also contribute to the involving of optical lines in this type of surveillance system [7, 6].

For these reasons, alternative approaches to loss decrease are required in optical amplifiers that amplify the optical signal directly without requiring transformation in the electrical signal [4].

One of the most effective methods of amplifying optical signals is the use of the non-linear effects of Stimulated Raman scattering and Stimulated Brillouin scattering. Optical amplifiers built on these effects, and in particular the Raman effect, can successfully replace optical repeaters, and even massive used Erbium-Doped Fiber Amplifier (EDFA) [4].

At the beginning of the 21st century, almost any long distances optical system (usually defined from 300 to 800 km) or ultra-long distances once (typically defined over 800 kilometers) uses the Raman Optical Amplifier (FRA).

A great FRA advantage is a very wide bandwidth amplifying which allows that to be used in various optical systems using the existing optical lines. The gain is accomplished in the fiber itself with significantly better figure noise resistant.

FRA gain using the transmission fiber as a carrier is an advantage technology in DWDM optical telecommunication systems. To amplify signal more pump power is needed, but thus the noise of Amplified Spontaneous Emissions (ASE) increases and other noises generated in the amplifier also reduces the power of the input signal to the amplifier. So, ASE takes an important part in transmitting the optical signal to the receiver [4, 5].

It is important to research the gain variation as a function of the signal power in the different pump configurations and fiber lengths. One of the main noises, namely ASE, can be used in the FRA. By adding ASE to the amplification process, it is possible to improve the amplifier operation and increase the gain of the amplifier [8].

2. Mathematical models on ASE influence on Raman Amplifier gain coefficient.

The FRA bandwidth is above 40 THz, with a dominant peak at 13.2 THz relative to the pump frequency (Figure 1) [3, 9].

The gain coefficient g_r is related to Raman's spontaneous scattering cross section, which is measured experimentally and generally depends on the optical fiber characteristics, and is also highly dependent on the polarization state between the pump and the signal. For a fiber of several tens of meters in length, propagation of the signal and the pump through it will cause the two states of polarization to decrease g_r .

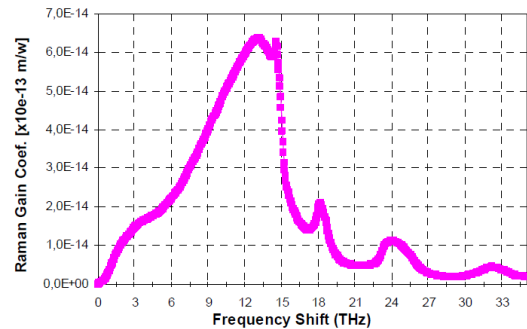


Figure 1. The Raman amplifier gain coefficient g_r for the wavelengths of the signal and of the pump [3, 9].

We examine the simplest case of spreading a beam entering in the optical fiber used for amplification.

It is necessary to calculate the amplification of Raman's amplifier signal with or without spontaneous emission.

2.1 Raman gain without amplified spontaneous emission.

The amplification of the signal and propagation of the pump signal along the length of the optical fiber is described by the following equations:

$$\frac{dP_s}{dz} = -\alpha_s P_s + \frac{g_r}{A_{eff}} P_p P_s \quad (1)$$

$$\frac{dP_p}{dz} = -\alpha_p P_p + \frac{g_r}{A_{eff}} \frac{\omega_p}{\omega_s} P_p P_s \quad (2)$$

where P_s and P_p are the signal power and pump power;

g_r is the gain coefficient to the Raman amplifier;

α_s and α_p are the optical fiber attenuation coefficients for the wavelengths of the signal and the pump;

ω_s and ω_p are carrier of signal waves and pump waves.

Second part of the equation (2) represents the transmitted power from the pump if we ignore it and solve the equation and replace in (1) the following expression:

$$\frac{dP_s}{dz} = -\alpha_s P_s + \frac{g_r}{A_{eff}} P_p(0) \exp(-\alpha_p z) P_s \quad (3)$$

Where $P_p(0)$ is pump power at $z = 0$.

After reading the length of the optical fiber, meaning $z = L$ and by the equation (3) is obtained

$$P_s(L) = P_s(0) \exp\left(\frac{g_r P_p(0) L_{eff}}{A_{eff}} - \alpha_s L\right) \quad (4)$$

where L_{eff} the effective length of interaction between the signal and the pump is determined by the equation:

$$L_{eff} = \frac{1 - \exp(-\alpha_p L)}{\alpha_p} \quad (5)$$

After integrating equation (4) for Raman gain coefficient [dB] is obtained:

$$G_s[dB] = -\alpha_s L + \frac{0,434 g_r P_p(0) L_{eff}}{A_{eff}} \quad (6)$$

where L_{eff} is effective length of interaction between the signal and the pump in meters.

2.2 Raman gain with amplified spontaneous emission.

ASE is a typical noise in optical amplifiers. FRA is used to increase amplification of the optical amplifier.

ASE is added to the signal power in equation (1). Then equation (1) takes the following form:

$$\frac{dP_s}{dz} = -\alpha_s P_s + \frac{g_r}{A_{eff}} P_p (P_s + P_{ASE}) \quad (7)$$

where $P_{ASE} = 2n_{sp} h \nu_s \Delta V_R$ and $h = 6,6260 \cdot 10^{-34} [m^2 kg / s]$ is Planck's constant.

$$n_{sp} = \frac{1}{1 - \exp\left(\frac{-h\Omega}{K_B T}\right)} \quad \text{is the spontaneous emission factor.}$$

$$\frac{dP_s}{dz} = -\alpha_s P_s + \frac{g_r}{A_{eff}} P_p P_s + \frac{g_r}{A_{eff}} P_p 2n_{sp} h \nu_s \Delta V_R \quad (8)$$

After reading the length of the optical fiber, meaning $z = L$ and integrating an equation (8) the gain with added ASE is obtained:

$$G_{ASE}[dB] = 0,434 \left(-\alpha_s L - \frac{g_r P_p(0) L_{eff}}{A_{eff}} - \frac{P_{ASE} g_r P_p(0) (1 - \exp(\alpha_s - \alpha_p) L)}{A_{eff} P_s(0) (\alpha_s - \alpha_p)} \right) \quad (9)$$

3. Simulations and results.

In order to study the impact of ASE on the FRA gain ratio, two types fiber optics, Standard single mode fiber (SMF) [1] and Non-zero dispersion-shifted fiber (NZ-DSF) [2] were used. The fiber parameters are given in Table 1.

Table 1. Fiber optic parameters

Optical fiber	Attenuation coefficients α_s [dB/km]	Wavelengths λ_s [nm]	Raman gain coefficient g_r [1/mW]	Fiber effective area A_{eff} [μm^2]	Fiber optic length [km]
SMF	0,13 dB/km	1550 nm	$4,2 \cdot 10^{-14}$	$80 \mu m^2$	100 km
NZ-DSF	0,18 dB/km	1550 nm	$4,2 \cdot 10^{-14}$	$72 \mu m^2$	100 km

To calculate the effective length of interaction between the signal and the pump, it is more convenient to translate the equation (5) L_{eff} into decibels.

It is more convenient to use an equation in which the attenuation coefficient set in the reference data in dB/km is used directly. Then (5) acquires the following form:

$$L_{eff} = \frac{4,343}{\alpha_p} (1 - \exp(-0,23 \alpha_p L)) \quad (10)$$

Figure 2 shows the results of the equation (10) of the effective length of the signal and pump interaction depending on the length of the optical fiber.

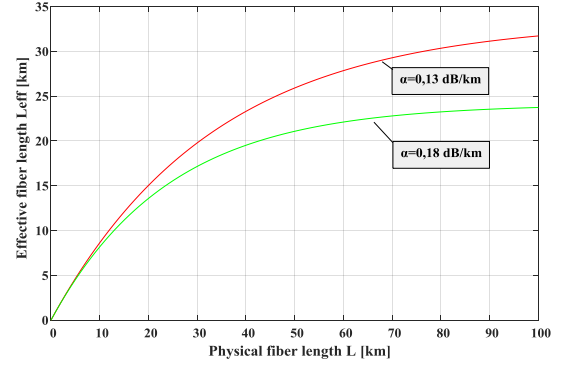
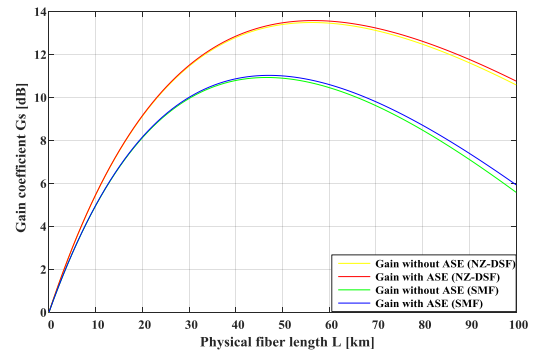


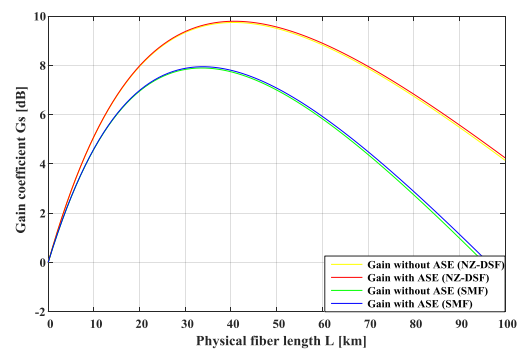
Figure 2. Effective fiber length L_{eff} for both fiber types.

The figure shows that L_{eff} depends on the attenuation coefficient, i.e. from fiber type.

Figure 3 shows the results obtained for the gain ratio using a pump with power $P_p = 500 mW$ and different wavelength. In the figure, the first graph is obtained with the pump attenuation coefficient $\alpha_p = 0,13 dB/km$, and the second with the attenuation coefficient $\alpha_p = 0,18 dB/km$.



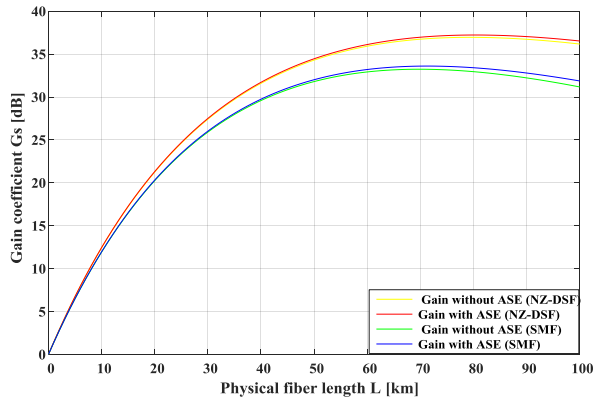
a) with $\lambda_p = 1450 nm$



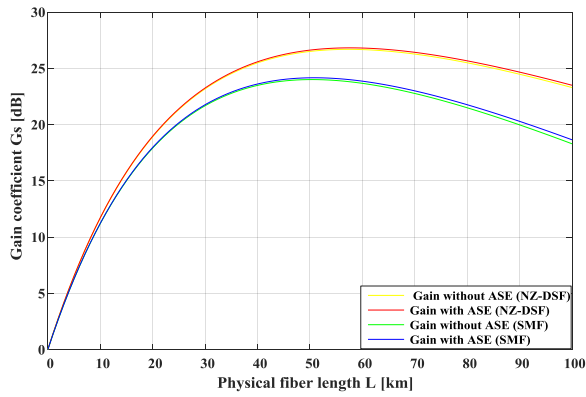
b) with $\lambda_p = 1460 nm$

Figure 3. The Raman amplifier gain coefficient with $P_p = 500 mW$.

Figure 4 shows the results obtained for the gain ratio using a pump with power $P_p=1000mW$ and different wavelength. In the figure, the first graph is obtained with the pump attenuation coefficient $\alpha_p = 0,13dB/km$, and the second with the attenuation coefficient $\alpha_p = 0,18dB/km$.



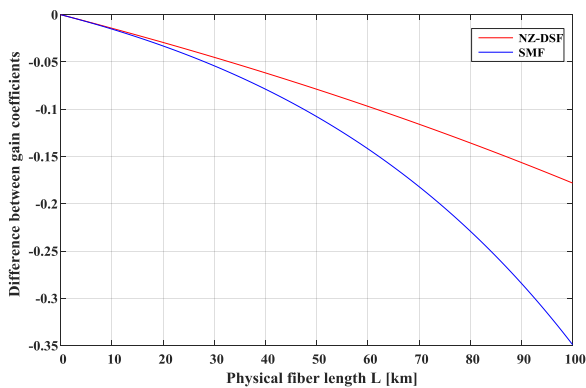
a) with $\lambda_p = 1450nm$



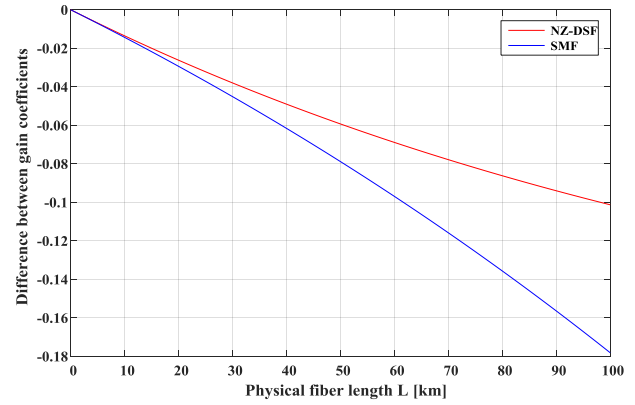
b) with $\lambda_p = 1460nm$

Figure 4. The Raman amplifier gain coefficient with $P_p=1000mW$.

Figure 5 shows a graph of the difference between ASE and non-ASE gains of different fiber types. The attenuation coefficient for the both pumps are respectively $\alpha_p = 0,13dB/km$ and $\alpha_p = 0,18dB/km$.



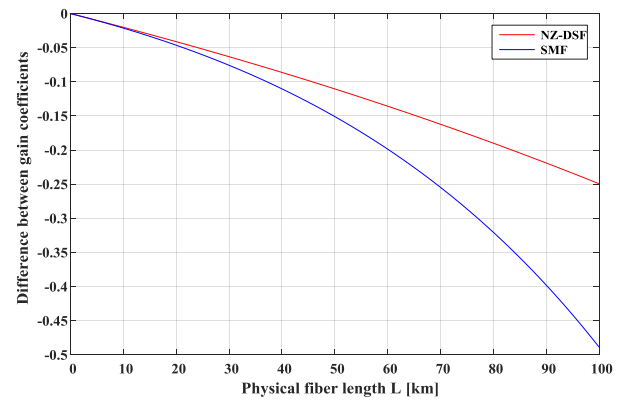
a) with $\lambda_p = 1450nm$



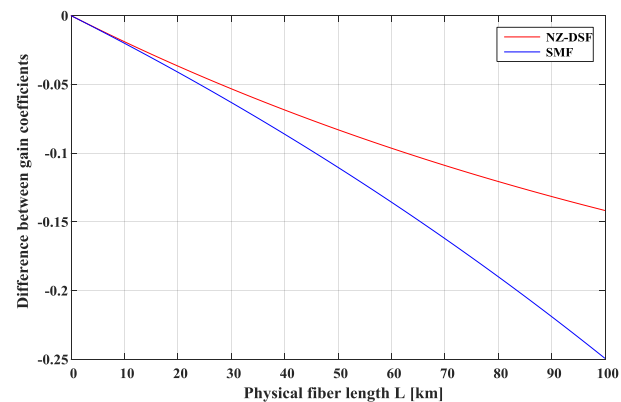
b) with $\lambda_p = 1460nm$

Figure 5. Subtraction the Raman amplifier gain coefficient with $P_p=500mW$.

Figure 6 shows a graph of the difference between ASE and non-ASE gains of different fiber types. The attenuation coefficient for the both pumps are respectively $\alpha_p = 0,13dB/km$ and $\alpha_p = 0,18dB/km$.



a) with $\lambda_p = 1450nm$



b) with $\lambda_p = 1460nm$

Figure 6. Subtraction the Raman amplifier gain coefficient with $P_p=1000mW$.

From the results obtained, it is seen that in order to achieve a higher amplification of the signal, higher pump power is required. At pump power $P_p=1000mW$ the gain is greatest.

The results show that the gain coefficient for both fiber types is higher when ASE is added in the amplification process.

When a specified wavelength of the pump is used, the ASE gain ratio is approaching the gain coefficient without ASE.

From the results derived for the difference between the gains for the two fiber types, it can be seen that the gain rate also depends on the fiber type.

4. Conclusion.

Choosing a suitable laser as a pump can reduce the number of amplifiers used in the long lines. Increasing the power of the pump also leads to a reduction in the number of amplifiers, but so far there are not as many powerful lasers to use in the FRA.

To achieve greater amplification, the selection of an appropriate laser is very important. By selecting a laser with appropriate wavelengths and an attenuation coefficient for a specific fiber type, we achieve a greater effect than ASE.

Using an appropriate fiber type will make a greater use of ASE in the amplification process.

The results obtained and the conclusions drawn show that long and ultra-long lines require a more detailed spontaneous emission study in order to increase the regeneration areas and reduce the number of amplifiers.

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NANOFIBER MEMBRANE START-UP

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Abstract: In 2004 Prof. Oldrich Jirsak from the Technical University of Liberec developed a machine for the industrial production of a nanofiber layer. Because of this equipment, new nanofiber layer oriented projects started to occur. One of such projects in recent years was a nanofiber membrane for use in sport and outdoor activities and also in the army. This project was a cooperation between the Technical University of Liberec and a Czech investor which led to the creation of a new company called NANOMEMBRANE. The result of their work is not only clothing with a nanofiber membrane, but also further cooperation between the private sector and a state university.

KEY WORDS: NANOFIBER MEMBRANE, START-UP, STATE UNIVERSITY, PRODUCT

1. Introduction

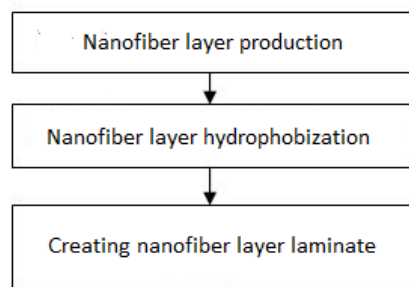
If you look up the term “start-up” on Wikipedia, you will see that there is not one unified/ universal definition, but that there are several of them. The one which best summarizes our project is the following one: “A start-up is usually a business plan at least in the stage of an idea which has the potential to be turned into a money making business model and which is trying to meet a market or business need in an innovative way. A start-up can be any new company, mostly technological, which is solving problems in a locally or timely innovative way.”

The first part of this article describes the development and production of a nanofiber membrane in our project and the second part shows how this project was turned into a new company called NANOMEMBRANE [1].

2. The development and production of a nanofiber membrane

Nanofibers can be called the material of the future. They can bring revolutionary changes in the fields of electronics, medicine, the car industry, filtration processes, ecology, nanocomposites, IT, personal protective equipment, clothing and many more applications.

Nanofibers are various polymer fibers of a diameter up to 500 nm. They are made by electrospinning and then processed into so far only nonwoven textiles. In 2004 the Technical University of Liberec patented a spinning machine called Nanospider [2]. This machine enabled the industrial production of a nanofiber layer and so started many research projects whose aim was to find new nanofiber based products. One of these products is our nanofiber membrane. Picture 1 shows the production of a nanofiber membrane.

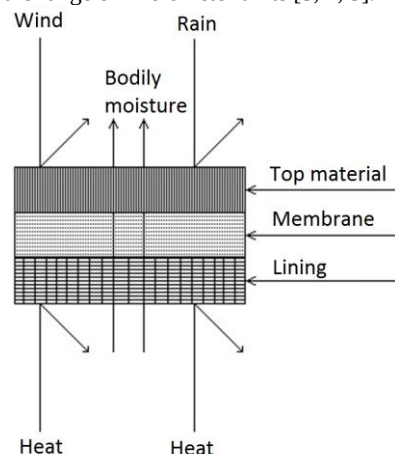


Pic. 1 production of a nanofiber membrane

3. Membrane for use in the clothing industry

In Pic. 2 you can see how such a nanofiber membrane for clothing works. Drops of water (snow, rain) fall on the top surface material. The top material tries to stop these drops from getting under this textile. This top material is often impregnated or has some chemical finish to achieve this, but at the same time it must be able to let water vapour through. This top material with its good properties has also got its limits and that's why a nanofiber membrane is added. The different materials (woven or knitted textile and nanofiber membrane) are laminated together to form 2-layer, 2.5-layer or 3-

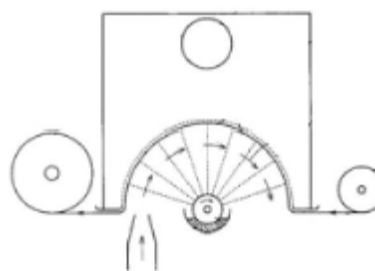
layer laminates. The membranes are made of polymers, the most common ones being PTFE (Polytetrafluoroethylene), PES (Polyethersulfone) or PUR (Polyurethane). The membrane thickness is in the range of micrometer units [3, 4, 5].



Pic. 2 The membrane function diagram

4. Nanofiber membrane development

A Nanospider machine was used to produce the nanofiber membrane (Pic.3). Polyurethan polymer was chosen because it is easy to use on a Nanospider machine, but also for its elasticity as it gives a final laminate tensibility that is very desirable in some kinds of closing.



Pic. 3: The Nanospider machine for the production of nanofibers by electrospinning [6]

The produced nanomembrane is made hydrophobic using Fluorocarbon type C6 monomer in low vacuum plasma to achieve a higher hydrostatic resistance. The hydrostatic resistance can be more than 20 000 mm depending on the top material laminated to the membrane.

After hydrophobization the nanomembrane is laminated together with other textile materials.

Many long-term tests have shown that a 3-layer laminate is the only solution for nanofiber layers as these layers are very susceptible to friction and for that reason must be well protected on both their sides by other textile materials laminated onto them. Pic. 4 shows such a 3-layer laminate.



Pic. 4 - 3-layer laminate cross-section

5. *Startup: Technical University of Liberec and the Svitap company*

The development of a nanofiber membrane started in 2009 when it was the topic of a final thesis under the supervision of the above-mentioned Prof. Oldrich Jirsak. The work continued in a postgraduate doctorate course and by the end of 2013 the nanofiber membrane development was complete, at least on laboratory equipment. At this stage an investor was sought out – a Czech company called Svitap J.H.J. which runs a technical textile business and has about 500 employees. The Technical University of Liberec and Svitap J.H.J. signed a contract about their cooperation. In this period of time a number of utility models and patents were registered. In 2015 a company called NANOMEMBRANE was created which started the production and sale of nanofiber membranes. The nanofiber membrane on its own won several significant awards. In 2017 the company's product range expanded, new product lines were added. Sports and outdoor clothing were

joined by a fashion line (laminates with natural textiles) and the membrane was also used in footwear production.

The NANOMEMBRANE company has its headquarters in Svitavy (a town between the cities of Prague and Brno) and employs 8 people. There are 4 owners of NANOMEMBRANE, one of which is the above mentioned Svitap J.H.J. company. Today, NANOMEMBRANE successfully sells its products (not all of them nanomembrane-based) but also closely cooperates with the state university. It has been the university's goal to find an investor who would be able to get the project from the development stage to production while at the same time would be interested in cooperation on new development projects, as it often can be seen in Western Europe and the USA.

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IMPROVEMENT OF THE METHODOLOGICAL APPROACH TO INVESTMENT PROJECTS' EVALUATION AMID DEVELOPMENT OF MARKET RELATIONS

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Abstract: The factors effecting evaluation of industrial enterprises' business plan risks have been defined. Types of risks, their characteristics and insurance forms have been studied amid current business environment. It has been pointed out that the criteria themselves are not enough to accept a project by an industrial enterprise. It has been proved that project's decision making has to meet all the criteria and stakeholders' interests of an investment project. The criteria based on value changes over time, which can be taken into account when evaluating comparable amounts of money separated by time, have been suggested.

KEYWORDS. RISKS, VALUE, EFFICIENCY, INVESTMENT PROJECT, CRITERIA, INDEXES, RESULTS, INVESTOR, FACTORS, PRINCIPLES, EXPEDIENCY.

Definition of the problem. In the project management process a significant role is played by methods, since they are applied to assess risks and threats of the environment, determine the project duration, main purpose, goals and objectives, create a project team, estimate funds, determine the volume of financial resources needed, estimate costs, generate the project budget, monitor and evaluate the effectiveness of the implemented project, make management decisions, sign contracts with suppliers. Thus, the process of organization of the project management system depends on the rational use of management methods.

Each management system should be based on the following principles: reduction of risks; increase in revenues; creation of conditions for achieving the desired result; costs evaluation and reduction; project adjustment and modification; balanced management decision-making; consideration of corporate strategy; adaptation to the environment variability; compliance of the project objectives with the enterprise's objectives; assessment of efficiency of investment project management; monitoring results.

Presentation of key topics. An enterprise in any form is related to risk. A risk is a danger of potential loss of resources or

receiving lower profits comparatively with the forecast variant. In investment activity a risk question is crucial. It is caused, at first, by considerable duration of an investment cycle from the moment of money investing the moment of their returning. On a long run it is difficult to forecast results, because different external factors can influence them: economic, political, social, ecological and other. Investing is related to allocating large amounts of money, material resources the ineffective use of which can negatively affect the financial state of an investor. Investing is carried out through the third persons (financial mediators), that is why an investor, as a rule, does not have the real opportunity to control the use of the invested means, to promptly interfere in a productive process and so on.

Taking into account all the above stated it is very important to correctly estimate and analyze possible risks, reduce directions of their avoidance and insurance in the process of development of investment business plan.

Estimating risks in a business plan is possible by means of determination of factors, presented in Table 1.

Table 1: Types of risks and form of their insurance

Type of risk	Risk level	Form of insurance of risk
Delay of the beginning of realization of an investment project (absence of license, project estimation documentation, lot land and so on)	Risk free investments	Development of effective prophylactic measures with the purpose of risks warning
Ill-timed completion of building (to determine reasons)	Possible	Creation of insurance (reserve) funds for losses coverage
The considerable exceeding of cost comparatively with project estimation documentation	Critical	Clear determination of duties and responsibilities of all participants of investment project, distribution of losses between them
A risk of not gaining project power in set terms	Catastrophic	Obtaining of certain guarantees from authorities
Risk of loss of sales market (decrease in demand, high level of competition)		External insurance against certain risks in insurance companies
Decline of the planned level of net income (increase of level of expenses, decline of standard of prices, change of tax law)		

Determining the type of risk it is necessary to estimate its level and influence on general results. It is difficult to find risk free investments in our country because not only economic but also political, social, ecological and other factors influence the risk level.

Investments with accepted risk level are those investments, which create the possibility to lose all net income on this investment project.

The criterion of critical level of risk is the possibility of losing of not only profit but of the whole yield. It means that it is impossible to take an investment project to implementation, if there can be the loss of profit in one of 10 cases, the loss of gross income in one of 100, and the loss of all invested property in one of 1000 cases.

Depending on the level of risk it is necessary to foresee measures of insurance against it (see table 1). Developing an investment business plan, the so-called bonus for a risk is to be set.

It is an original additional profit which is required by an investor for the risk. This profit margin is to increase proportionally to the increase of risks on a certain investment project.

General income (profit) on an investment project taking into account the level of its systematic risk is possible to be calculated according to the formula

$$P_g = P_{rf} + (P_a - P_{rf})\beta \quad (1)$$

where P_{rf} is a level of profit from risk free investments;

P_a is an average level of profit at the investment market;

β is a beta-coefficient which characterizes the level of systematic risk from this investment project [1, c.101; 2, c. 105; 3, c. 136].

The economic analysis of efficiency of an investment project presupposes studying indexes which represent the correlation of expenses and profits in accordance with interests of

its participants. The following indexes of efficiency of an investment project are differentiated:

- indexes of financial efficiency, which take into account the financial consequences of a project for its direct participants;
- indexes of budgetary efficiency, which depict the financial consequences of a project for the state, regional or local budget;
- indexes of economic efficiency, which take into account expenses and results of a project that are of indirect financial interests for participants [4, c. 178].

The expenses of participants of an investment project are subdivided into primary (capital forming investments), current and liquidation, which are carried out accordingly on the stages of building, functioning and liquidation.

The estimation of future expenses and results when determining the efficiency of an investment project is carried out within the limits of calculation of the period the duration of which considers:

- the duration of creation, exploitation and (if necessary) liquidation of an object;
- average weighted normative period of employment of basic technological equipment;
- achievement of the set income (masses and / or norms of income, et cetera);
- requirements of an investor [5, c. 195; 6, c. 52; 7, c. 101].

The horizon of calculation is measured by the amount of steps of calculation. The step of calculation when determining the indexes of efficiency within the limits of calculation period are the following: month, quarter or year.

Comparison of different investment projects (or alternative designs) and the choice of the best are recommended to do with the use of different indexes, some of them being the following: net market value; term of recoupment; profit margin of a project; internal norm of profitability; return on funds of a project.

The use of indexes for comparison of different investment projects (alternate designs) is possible if they are brought to the comparable kind.

Besides the criteria listed above in a number of cases it is possible to use some other: integral efficiency of expenses, threshold of break-even, simple norm of income.

None of the transferred criteria is insufficient for the acceptance of a project. The decision about the acceptance of a project must be made taking into account the values of all transferred criteria and interests of all participants of an investment project.

The necessary criterion of acceptance of an investment project is positive balance of the accumulated real money at any period, where a participant of an investment process carries out expenses or gets profits. The negative balance of the accumulated real money testifies the necessity of attracting of additional own or loan funds and reflection of these means for efficiency calculations.

The most difficult stage of an investment analysis is calculation of the flow and balance of the real money. They must be formed in the way that the balance of the accumulated real money is positive.

An important role in estimation of efficiency of an investment project is played by the change of money value in time and other factors. Some of these factors are subject only to content (but not formal) analysis.

Planning of investments, determination of their expediency, profitability is always forecasting of future profits and expenses that is money streams. When estimating the compared in time volumes of money, it is necessary to take into account the change of their value.

In general the changed in time money value is determined according to the formula:

$$F_t = P(1 + r)^t \quad (2)$$

where F_t , P is money value accordingly in the future and today;

$(1 + r)^t$ is a coefficient of compounding;

r is an annual bank rate;

t is a number of year (beginning from the next), which corresponds to value P [8, c. 164; 9, c. 253; 10, c. 297].

Such transition from the evaluation of current money value to their future value is called compounding.

The reverse process of getting the market value of the future money is referred to as discounting.

The general formula of bringing the money of future period (F_t) to the equivalent amount of current year (P) is the following:

$$P = F_t / (1 + r)^t \quad (3)$$

where r is a rate of discount;

$1/(1+r)^t$ is a discount factor [11, c. 77; 12, c. 765; 13, c. 94].

If the level r is forecast variously for different years, the formula of bringing the money of future period to the equivalent amount of current year is the following:

$$P = F_t / \{(1 + r_1)(1 + r_2)...(1 + r_t)\} \quad (4)$$

The basic principle of evaluation of efficiency of investments is comparison of profits and expenses. When reasoning the economic efficiency of investment projects, the complex of indexes representing different aspects of the already noted principle and enable to estimate expediency of investments is applied.

From positions of expert estimation the realization of an investment project can be presented by two interdependent processes: money investing in a project; getting profits from the invested means.

Thus the direct object of the financial analysis and determination of economic efficiency of an investment project are direct financial flows (so-called cash flow). When calculating direct financial flows it is worth considering the fundamental difference of concepts of inflows and outflows of the real money from the concepts of profits and expenses. There are certain nominal money expenses, such as depreciation of assets, amortization of fixed assets, which diminish net profit, but does not influence the flows of real money, because nominal money expenses does not require money calculation.

All expenses are subtracted from profits and influence the amount of net income, but not at all expenses require real money calculation. Such expenses do not influence the flow of real money.

On the other hand, not all cash disbursements (which influence the flow of real money) are fixed as expenses. For example, the purchase of inventory is considered the outflow of real money, but not an expense.

To set the order of calculation of financial flows and their indexes we will enter conditional denotations:

P is a volume of cash from economic activity of an object of investments after its introduction to exploitation;

B_i is a volume of investments which are needed for introduction of an object to exploitation (investment expenses);

B_e is a volume of current expenses of an operating object, necessary for production of commodities or services, produced by the created object (operating expenses);

A_t is depreciation of capital assets, created due to investments accrued for a year;

T is years of life of a project (exploitation of an object and profits from investments);

t is an index (number) of every year of exploitation of an object

$t = 1, 2, \dots, T$.

A net present value (NPV) is an amount of annual profits without expenses. The net present value NPV is calculated at the set norm of discounting (coercion) according to the formula:

$$NPV = \sum_{t=1}^T \{(P_t - B_{it} - B_{et}) / (1 + r)^t\} \quad (5)$$

An economic content of the rate of discounting is as following: its value is the minimum acceptable to the investor standard of yield on a capital (as a rule, it is a rate of attraction of deposits in commercial banks) [13, c. 96].

NPV is to exceed 0 for a project to be accepted. If NPV of an investment project is positive, a project is effective (at this norm of discount) and can be accepted. The higher NPV is the more effective the project is. If an investment project is carried out at negative NPV, an investor will sustain loss, that is a project is ineffective.

The term of recoupment of a project (T_k) determines the number of years for which the general income will equal the investments. Its equals the following value of t ($T_k=1$):

$$B_i = \sum_{t=1}^{T_k} \{(P_t - B_{et}) / (1+r)^t\}. \quad (6)$$

A term of recoupment must be less than the general term of life of a project: $T_k < T$. T_k - a number of years, necessary for the income from investments to be equal to the volume of B_i ; r is an annual rate of discount, which is to be applied for yields of future periods to the conditions of current year; K is a coefficient of coercion [12, c. 767]:

(7)

$K = \text{of } 1/(1+r)^t$.

Results and expenses, related to a project are to be calculated with or without discounting. Accordingly, there are two different terms of recoupment. The term of recoupment is recommended to be determined with the use of discounting.

The margin of profit of a project (g) is calculated as correlation of net present value of profits for period of life of a project to the volume of capital investments. The projects which margin of profit exceeds 1 are recommended for realization. The profit margin of settles accounts after a is calculated according to the formula:

$$g = \frac{\sum_{t=1}^T \{(P_t - B_{et}) / (1+r)^t\}}{\sum_{t=1}^T \{B_{it} / (1+r)^t\}}. \quad (8)$$

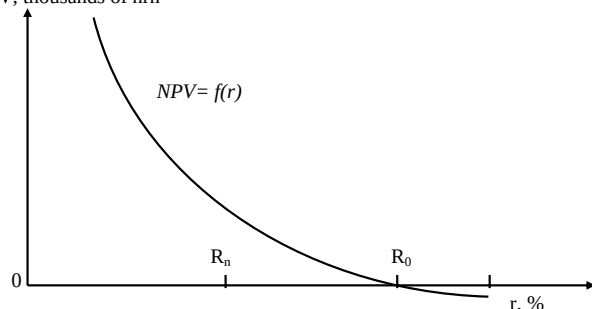
The internal norm of profitability of a project (R) is determined as a level of a rate of discounting (r) at which the net present value of a project (for the whole life cycle) equals zero, that is

$$NPV = \sum_{t=1}^T \{(P_t - B_{it} - B_{et}) / (1+R)^t\} = 0 \quad (9)$$

An internal norm of profitability is a limit, below which a project gives negative general profitability. The value of R calculated for a project must be compared to its normative level for similar projects. If $R > R_n$, a project can be accepted, if $R < R_n$, a project is rejected.

The value of R is calculated by the method of selection and verification of successive values of expression of r ($r > R_n$) with the use of the computer programs or graphic method of construction of function of dependence between NPV and r (Picture 1)

NPV, thousands of hrn



Picture 1 Dependence between NPV and r .

For every project depending on the criteria used by experts, the level of R_n can be different depending on a macroeconomic situation in a country, level of risks in a region,

industry, project, average profitability of an enterprise-investor, cost of its capital, correlation of the borrowed and own capital and other reasons.

If the calculation of NPV of an investment project gives an answer to the question about project effectiveness at a set norm of discount, R of a project is determined in the process of calculation and then compared to the norm of yield on the invested capital.

In the case when NPV is equal or more than the necessary for an investor norm of yield on a capital, investments in this investment project are justified. In the other case investment in this project is inadvisable. If comparisons of alternative (mutually exclusive) investment projects (alternate designs) for NPV and R result in opposite results, the value of R is of higher priority [13, c. 113].

The value of return on funds of a project (f) is calculated as a relation of average annual income for the life of a project to the average annual remaining cost of investments for the same period taking into account their annual wear:

$$f = \frac{\sum_{t=1}^T \{(P_t - B_{et}) / T\}}{\sum_{t=1}^T \{(B_{it} - A_t) / T\}}. \quad (10)$$

This index determines the level of average return (income) from every cash unit of the used investment money.

As far as a foreign investor the calculations of flow of real money are conducted only in currency of the corresponding country, with transferring in the dollars of the USA or Euros. For additional confirmation of economic efficiency of a project with foreign participation it is recommended to compare it to the similar project which presupposes the Ukrainian participants only. The comparison of different investment options, reasoning of sizes and forms of foreign participation in a project is performed by the criterion of maximal economic effect for the economy of Ukraine.

An internal norm of profitability is a new and most difficult in calculations index. It characterizes the level of profitability of a certain investment project (in percents) in the form of a discount rate in amount at which a future volume of money flow is brought to the present value of the investments. In other words, the internal norm of profitability can be described as a discount rate at which the net brought profit over in the process of discounting will equal zero.

The index of the internal norm of profitability is used mainly for the comparative estimation of efficiency of investments. By comparison of two and more projects additional variant which provides the greatest level of profitability can be developed.

The indicative planning of building production is important for timely providing an investment process with necessary capacities of producers of material and technical resources and construction firms. That means that they forecast the development with the purpose of providing of implementation of the expected investments. The indicative plan of construction can presuppose the following indexes:

- volumes of construction and installation works at the estimate cost of state objects, including those, that are to be started in a planned period;

- an estimate cost of works which can be executed by contractors, economic or mixed methods;

- volumes of works which are financed by private investors, including possible introduction of these objects in a planned period;

- introduction in an action of capacities, including due to new construction, reconstruction, technical reequipment and expansion of production;

- introduction in an action of objects of social sphere including those which are financed by private investors.

Timely worked out and proclaimed by the Ministry of Economy plan of investing of the state will allow potential investors, state and private enterprises producing and supplying with material and technical resources for construction, project and

construction firms to study these indicators, determine their intentions of participating in competitions and tender auctions, and to form the portfolios of orders and conclude contractor treaties.

The title of a structure (object) determines main technical and economic indexes: capital investments and tasks of introduction of capacities and capital assets for the period of building with distribution for periods. Indexes of titles of structures are planned both for a customer and for a contractor, obligatory for ministries and other central and local authorities, enterprises, establishments, banks, which carry out support, financing and realization of construction project.

Titles are drawn up only for those structures, which have the ratified project estimation documentation by September, 1 of year which is preceded to the planned. Titles of starting structures, titles of transitional structure and internal titles are distinguished.

The order of production titles ratification is the following:

- the calculated estimate cost of 15 mln. hrn is ratified by the central organs authorities and regional state administrations and is agreed with the Department of economics of Ukraine;

- the calculated estimate cost up to 5 mln. hrn. is ratified by the top management of state enterprises agreed with the authorities of higher level.

Conclusions. In recent years there has been a rapid deterioration of enterprises' economic development, which affected crisis phenomena development in the country. It was caused by reduction in investment, increase in threats from external environment, lack of an effective mechanism and techniques of investment project management. Therefore, in order to improve the development of enterprises, organizations and banking institutions, the availability of an investment project management system, which will create opportunities for successful implementation of investment projects, is of crucial importance. There are different approaches to research of management systems, which have both advantages and disadvantages, but many problems remain unsolved, namely the issue of improving profitability, efficiency and timely consideration of market environment threats. Therefore, the problem of investment project management system at industrial enterprises is of relevance.

As well, the relevance of the given issue lies in the fact that not only do investment projects improve the country's economic and social development, they also increase export potential of enterprises and enable investors to identify investment areas with the view of attaining the objectives.

At the present stage of its development Ukraine's economy is experiencing essential changes: there is a decrease in net profits due to reduction in production volumes and sales, which ultimately affects enterprises' activities as well as circulating assets backing and results in employee layoff with the view of saving own funds. However, on the other hand, there are favourable conditions for development and implementation of investment projects aimed at enhancing financial activity of enterprises. In our opinion, the basic premise for regulating enterprises' development is implementation of investment projects, which enable efficient use of investments, growth of production and generation of competition. In addition, in recent years there has been a decrease in attracted investments due to aggravation of social, economic and political problems, shortcomings of the tax reform, increase in the tax burden and reduction of long-term loans. Therefore, there is a need to use investment projects not only for increasing revenues but also for introducing the latest equipment and modern technologies, promoting activities and development of industrial enterprises through making rational management and organizational decisions. Accordingly, the sustainability of the country's development in general as well as of regions and enterprises' development in particular depends on investment that is on investing processes. This is investment that allows us to introduce the latest technology and equipment, which increases productivity and provides a rise in production volumes and, as a result, more efficient development of enterprises. At the same time, the main purpose of investment is making profits and achieving the goal, therefore investors only allocate funds to promising companies, which possess a growth

potential. The relevance of this issue lies in the fact that not only do investment projects improve the country's economic and social development but also increase export potential of enterprises and enable investors to identify investment areas to achieve their goals.

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APPROACHES AND CHALLENGES IN THE APPLICATION OF HIGH TECHNOLOGY IN THE INDUSTRY

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Abstract: Increasing competition in the market requires manufacturers to bring high technology solutions to optimize production processes on the one hand and to offer personalized products on the other hand. In the current conditions of digitization, namely the application of information and computer technologies requires the use of new management approaches. The report attempts to systematize the approaches and challenges of applying high technology to the modern industry.

KEYWORDS: HIGH TECHNOLOGIES, APPLICATION APPROACHES, INDUSTRY

1. Introduction

The requirements of the EU directive on digitization of the economy determine the steady growth of investments with high added value. High technologies penetrate in parallel in many sectors, such as electronics, machine building, power engineering, etc. The main factors behind these technological advances are: increasing user requirements on personalizing products, integration of users in the design process, the reorganization of the value chain and the rapid development of information and communication technologies.

2. Approaches to the application of high technology in the industry

A. Product Life Management PLM

Introduction of intelligent technological equipment to all activities, during the life-cycle of the product (repair, maintenance, correction, etc.), as well as the purposes and conditions of use of the product are automatically recorded and stored. This necessitates a transparent product life-cycle management (Product Life - Management PLM). The purpose of this approach is to develop an individual product, but with series of production requirements. Integrating user requirements and optimizing costs, time and quality throughout the product's life-cycle. This requires a comparison of the requirements of market / client / company / regulatory requirements, Fig.1.

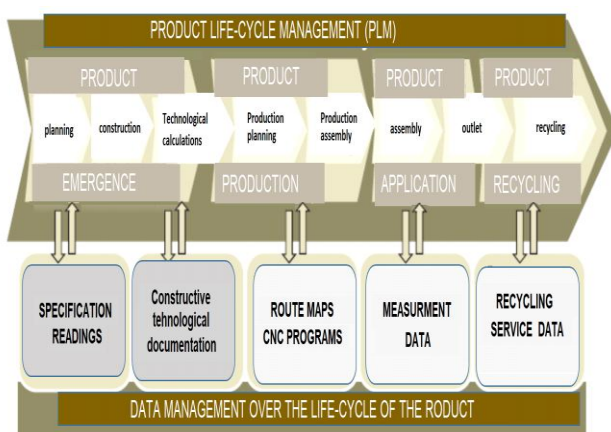


Fig.1 Managing the life cycle of the product

B. Partial (segmented) approach

Integration of technology components can bring enormous potential, but it is also associated with much higher requirements. That is why we are talking about so-called "isolated solutions" or segmented development of a partial system to the transition to high technology, which is called a segmented (partial) approach, Fig.2.

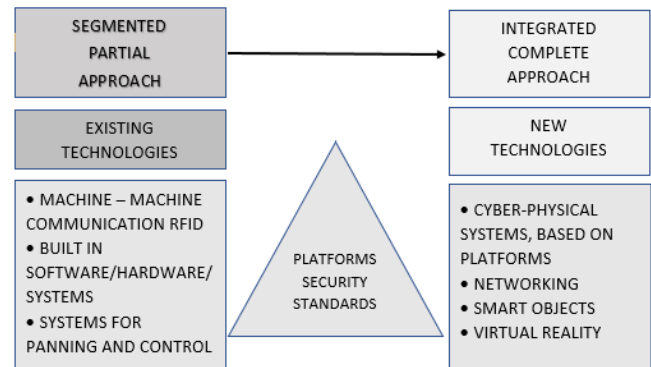


Fig.2 Characteristics of the partial approach

C. "Step-by-Step" Approach

From the standpoint of individual companies, greater flexibility and cost savings can be achieved by integrating suppliers and customers, as well as transport systems. Using technology as well as real-time transport statistics monitoring will allow to specify their expected arrival time and content (e.g. transport from the front door of the warehouse accompanied by RFID-control of the goods transported. The system also deals with vehicle availability notification and warehouse space management). With this strategy, it is possible to improve internal logistics processes, but also to develop new business models.

D. A holistic approach to optimizing the overall technological chain

Requirements for manufacturing companies resulting from the further development of information technology, can not be achieved only by focusing on the automation of the production process, but it is necessary to create and implement a comprehensive one (holistic) technological approach throughout the value chain – from product design through planning and manufacturing to after-service, Fig.3.

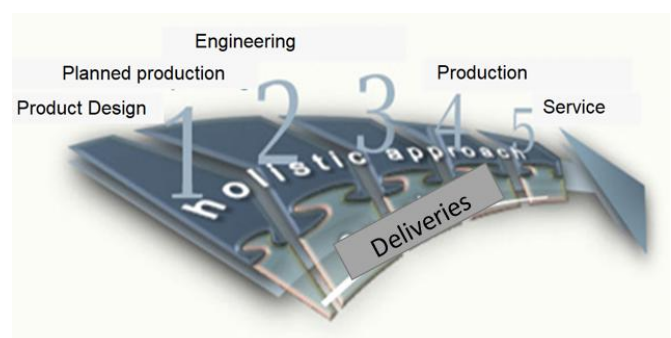


Fig.3 Holistic Approach (Siemens)

This approach is related to the definition of the product idea, study of its maintenance and its use until it is out of use, with special attention being paid to integration and without a problem technical connection and data exchange with the network. This means intensity of the **socio-technical** interaction of all participants in the production and the resources. The focus is on a network of autonomous, situationally controlling, knowledge-based configuration, based on sensors and spatially distributed production resources like machines, robots, transport and storage systems, control systems and their planning, and others.

3. The pyramid of automation

The introduction of high technology and "smart" products is closely related to the pyramid of automation, the basis of which are the automated technical process control systems (SCADA), in the middle part are located the MES systems, and at the top of the pyramid - ERP systems. The pyramid represents the information flows from the work centers (machinery, equipment, jobs) to the top management of the organization. From the different industrial controllers and sensors these systems collect data, which come into the modules of the MES systems, which are located in the offices of the production units. After processing of the data, they become management information, which enters the ERP system, which functions in the organization's middle management units. The pyramid of automation consists of six base levels (0 to 5), which correspond to different levels of automation of the manufacturing in a company. Individual pyramid levels of automation can be determined as follows, Fig.4. :

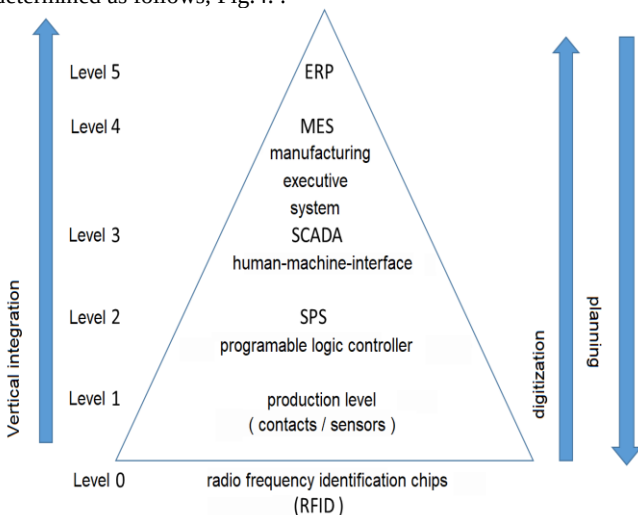


Fig. 4. The pyramid of automation

The boundaries of the classic pyramid of automation are mainly in the implementation of data transmission and processing, as advances in the development of Network Industrial Components in the Internet of Things and Services (IoTS), affects the amount of processed data. Growing volumes of data (Big Data) in the future can lead to business and corporate problems, because the higher the level is in the pyramid of automation, the more it reduces the transmission speed. One solution to this problem is data collection and application of "cloud services". The collected data can be stored quickly and safely in the cloud service, to be stored and revised through analysis and submitted to management and control level. The development of IT support at all hierarchical levels leads to new trends, namely increasing information flows at all levels and thus the need for a new "Reference model of industrial information architecture", which should reflect the three dimensions of vertical and horizontal integration, as well as life-cycle integration of production equipment.

4. Information security

Risk management for information security is a component of high technology, which includes defining the exact context, analysis and continuous monitoring. The risk management strategy for information security is the decentralization of electronic information (modular approach), which ensures continuity of the processes, while ensuring information security. Any interested person (operator, supplier, customer) has access to limited information structured in modules.

5. Consequences of the implementation of high technology

New value creation chains and business technology models lead to the creation of new alliances and interconnections between enterprises and this has a huge impact on the organization of labor. Thanks to the rapidly evolving digital technology in the industry and especially in the business services sector new forms of work organization and employment are constantly emerging and skills are being updated. These transformations should be carefully monitored. People at all levels should be prepared to learn new skills, which in view of the enormous social challenge, gives even more ground to encouraging curriculum updating and lifelong learning. Studies or evaluations of the transformation process should help to identify correctly the necessary professional skills and the need for qualification.

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BIOPHYSICAL COEFFICIENT OF LONG-FRUIT CUCUMBERS GROWN IN DRIP IRRIGATION CONDITIONS

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Summary: Experimentally, the evapotranspiration and evaporation from the free water surface of long-fruit cucumbers grown under greenhouse conditions was established. Based on the calculated values of the evapotranspiration based on the soil humidity dynamics data during the vegetation period, the irrigation carried out and the evaporation from the free water surface determined by a class "A" evaporator, the values of the coefficient of the culture in unheated plastic greenhouses were calculated as an average for the vegetation process of cucumbers K_i is 1,46. Establishing a correlation between ET and E_o under greenhouse conditions allows a safer use of Class A evaporator data.

KEY WORDS: EVAPOTRANSPIRATION, EVAPORATION, BIOPHYSICAL COEFFICIENTS, CUCUMBERS, IRRIGATION RATE, DRIP IRRIGATION.

Introduction

In our and world practice a number of empirical and theoretical methods and approaches are used to determine the dependence between: evapotranspiration and meteorological factors, evapotranspiration and evaporation from free water surface, evapotranspiration and heat exchange of soils, etc. It is considered that the correlation between evapotranspiration and evaporation from a free water surface, established by a "A" evaporator, is considered to be accurate and practical,

Finding the connection between the evapotranspiration and the factors that determine it makes it possible to determine in advance the irrigation time, which is an important element in the realization of a proper irrigation regime.

Predicting evapotranspiration with a high degree of accuracy, given the need to satisfy the plants' needs with water, is of great importance for the practice. When growing vegetables in drip irrigation facilities where plants almost daily need to recover the amount of water they spend, the problem of forecasting water needs and watering times is a factor in yields.

Little and insufficient are the studies to establish the evapotranspiration of vegetable cultures grown in greenhouse conditions. In the cultivation of pepper in drip irrigation in unheated greenhouses in the Sofia region, the ET reached 668 mm (Kireva, 1989) and in the region of Plovdiv up to 554 mm (Basitov, 2006). For greenhouse tomatoes, ET reached 373 mm (Abobamera, 1992).

The aim of the research is to determine the size of the evapotranspiration and the values of the biophysical coefficients of long cucumbers grown under greenhouse conditions with drip irrigation in the Sofia field.

Materials and method

To establish the evapotranspiration of long-fruit cucumbers, which is necessary to calculate the biological coefficient, during the period 2002-2004 a field experiment was conducted in plastic unheated greenhouses at the experimental field of the Pushkarov Institute in Chelopechene, Sofia

The experiment was conducted on leached Chromic cambisols, which is characterized by the following water - physical properties: WHC - 20,2 with respect to the absolute weight of the soil; bulk density at WHC 1.54 g / cm³; wilting point 10.38% relative to the weight of absolutely dry soil.

The following irrigation options have been tested:

- Option 1 irrigation with 100% water application rate
- Option 2 irrigation option with 80% water application rate
- Option 3 irrigation with 60% water application rate

The experimental determination of the evapotranspiration of the long-fruit cucumbers for the vegetation period is based on the measurements of: the soil moisture during the vegetation period and the irrigation carried out, for a variant with 100% realization of the irrigation norm, layered at 10 cm and total for the soil layer 0-50 cm

, by the water balance method. This layer contains more than 85% of the main root system of the culture.

On the basis of data on soil moisture dynamics during the vegetation period, the irrigation water drainage carried out has established the evapotranspiration (ET) of long-lasting cucumbers in ten days and in general for the vegetation period.

The size of the water application rate is calculated using the formula by (Frecman and Garzoli, 1980).

On the basis of the calculated values of evapotranspiration and evaporation from a free water surface (evaporation) established by a Class "A" evaporator, as it is considered to be integrative for all meteorological factors that influence it (Goldberg, 1976, Rey, R. 1979) the biological factor of long-fruit cucumbers is defined by the formula:

$$K_i = \frac{ET}{E_o}$$

where: ET is evapotranspiration in mm;

E_o - evaporation from free water surface (evaporation) with evaporator class "A" in mm;

K_i -coefficient of the crop;

The water-balance calculations are made according to the formula:

$$ET = W_{\text{нач}} - W_{\text{кп}} + m,$$

where: ET is evapotranspiration, mm;

$W_{\text{нач}}$ - water stock in the 0-50 cm layer at the beginning of the period for which ET is calculated, mm;

$W_{\text{кп}}$ - water stock in the 0-50 cm layer at the end of the period, mm;

m - irrigation rate, mm.

The biological coefficient reflects the specifics of water consumption depending on the biological requirements of the crop, the stage of development, the manifestations of the meteorological factors.

Results

The main part of the water consumption of long-fruit cucumbers grown in greenhouse conditions is from evapotranspiration. It does not differ significantly from the irrigation norms and varies in years. Depends on the meteorological situation and the irrigation regime applied.

In the initial phase of crop's development, the average daily values of the evapotranspiration are lower, due to the smaller size of the plants, which consume small amounts of water, a large part of the soil surface is opened, the impact of the meteorological factors is low. The magnitude of evapotranspiration during this period is mainly determined by soil humidity and near-ground air temperature. The physical evaporation of the soil prevails. The intense increase in ET , which begins in the first and second quarters of June, is associated with an intensive growth phase and reaches a mean daily value of 3.8 to 4.6 mm.

Its maximum for the three years is in the first and second tenth of July and reaches 5.5 mm. At the end of the long-fruit cucumber's

vegetation, with decreasing the pressure of the meteorological factors, the medium-term ET decreases and in the first ten days of August it reaches 3.7 mm (Table 1).

Table 1: *Evapotranspiration and evaporation from free water surface of long-fruit cucumbers 2002-2004*

Months	Average daily evapotranspiration (ET) mm					Average daily transpiration from a free water surface (Eo) mm			
	Ten days	2002 г. mm	2003 г. mm	2004 г. mm	Average mm	2002 mm	2003 mm	2004 mm	Average mm
May	II	0,4	0,5	1,0	0,5	-	2,0	2,2	2,2
	III	1,8	2,0	2,0	2,1	2,5	2,0	2,0	2,2
June	I	4,2	3,1	4,0	3,8	2,4	2,5	2,2	2,3
	II	4,7	3,8	5,0	4,6	2,7	2,9	2,3	2,6
	III	4,8	4,6	5,5	5,2	2,7	3,0	2,7	2,8
July	I	5,4	5,40	5,3	5,3	3,2	3,0	3,6	3,3
	II	5,3	5,8	4,7	5,4	3,5	2,0	2,2	2,8
	III	4,1	6,5	4,2	4,7	2,9	2,8	3,0	2,9
August	I	3,6	5,1	3,9	4,4	2,8	2,5	3,5	2,9
Total		3,9	4,1	4,0	4,0	2,9	2,7	2,6	2,7
Total Eo		223	253	217	231	232	240	238	237

When growing crops in cultivation facilities with drip irrigation where plants almost daily need to recover water, the problem of forecasting the amount of water required is of paramount importance. It is best determined by the correlative dependency of the evaporation of a free water surface (Eo), established by a class "A" evaporator, integrating all the weather factors that influence it (Goldberg, 1976, Rey, R. 1979).

The results obtained on average for the experimental time, indicate that the total growing season of the crop the evapotranspiration of free water surface (Eo) is 237 mm and reaches the highest daily average values in the second and third ten-day period of July (Table 1). The reached average daily values of the evapotranspiration are higher than those of the evaporation. The largest differences are occurring during the period of mass fertilization of the crop in the months of June-July, when the pressure of the climatic factors is greatest.

The Ki coefficient, which reflects the relationship between evapotranspiration and evaporation from free water in open

areas, according to Alpev's theory, it is approximately equal to a unit for the growing season of the crop.

Determination of the dependence between Eo, determined by "A"-class evaporator, and ET of the cultures allows to prognose the daily dimensions of ET of the culture and from there to predict the terms and sizes of the forthcoming harvests. (Christiansen, 1976).

After processing the information for the three experimental years of growing long-fruit cucumbers under greenhouse conditions, the average value of the crop coefficient (Ki) for the vegetation period was calculated. For the period, the coefficient (Ki) varies in ten days periods from 0.4 to 1.9 and reaches the highest values in the second ten-day period of July - the period of the highest stress of the meteorological factors and the highest evapotranspiration. The set values of the biological coefficient represent an objective basis for defining the design irrigation regime and forecasting the irrigation time of the crop (Table 2).

Table 2: *Average rates of the biological coefficient of long-fruit cucumber, grown in non-heated greenhouses with drip irrigation*

Months	Ten days	evapotranspiration /ET/,mm	Evaporation /Eo/, mm	Coefficient of the crop $Ki = \frac{ET}{Eo}$
May	II	0,5	2,2	0,2
	III	2,1	2,2	1,0
June	I	3,8	2,3	1,7
	II	4,6	2,6	1,8
	III	5,2	2,8	1,8
July	I	5,3	3,3	1,7
	II	5,4	2,8	1,9
	III	4,7	2,9	1,7
August	I	3,7	2,9	1,3
Total		4,0	2,7	1,46

Conclusions

1. There is a relationship between the Evaporation (Eo) determined with the evaporator class "A" and the evapotranspiration (ET) in the case of long-fruit cucumbers grown in unheated greenhouses, which allows to predict the daily values of ET.

2. On the basis of the established relationship between the evapotranspiration (ET) and the equation (Eo) the values of the coefficient of culture (long-fruit cucumbers) in unheated plastic greenhouses, ten days and for the whole vegetation period, were calculated.

3. The determined biological coefficient values are an objective basis for determining the design irrigation regime and forecasting the irrigation time of the crop

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DEVELOPMENT OF URANIUM MINING AND URANIUM PROCESSING IN THE RUSSIAN FEDERATION

РАЗВИТИЕ НА УРАНОДОБИВА И УРАНОПРЕРАБОТКАТА В РУСКАТА ФЕДЕРАЦИЯ

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Abstract: The Russian Federation average about 3000 tons of uranium per year from its own mines. Russian uranium mining companies work in Kazakhstan, Canada and other countries either directly or through companies they purchase. Its businesses export fuel in all parts of the world and are getting more stable on the world market despite the sanctions imposed.

Keywords: Uranium production, Russian Federation, mining,, domestic mining, regulation, safety, Export

1. Introduction

Russia has substantial economic resources of uranium, with about 9% of world reasonably assured resources plus inferred resources up to \$130/kg – 505,900 tonnes U (2014 Red Book). Rosatom reported ARMZ resources as 517,000 tU in September 2015, mostly requiring underground mining. Historic uranium exploration expenditure is reported to have been about \$4 billion. The Federal Natural Resources Management Agency (Rosnedra) reported that Russian uranium reserves grew by 15% in 2009, particularly through exploration in the Urals and Kalmykia Republic, north of the Caspian Sea.

Uranium production has varied from 2870 to 3560 tU/yr since 2004, and in recent years has been supplemented by that from Uranium One Kazakh operations, giving 7629 tU in 2012. In 2006 there were three mining projects in Russia, since then others have been under construction and more projected, as described below. Cost of production in remote areas such as Elkon is said to be US\$ 60-90/kg. Spending on new ARMZ domestic projects in 2013 was RUR 253.5 million, though in November 2013 all Rosatom investment in mining expansion was put on hold due to low uranium prices.

Russia uses about 3800 tonnes of natural uranium per year. After enrichment, this becomes 190 tU enriched to 4.3% for 9 VVER-1000 reactors (at 2004, now 13), 60 tU enriched to 3.6% for 6 VVER-440s, 350 tU enriched to 2.0% for 11 RBMK units, and 6 tU enriched to 20% (with 9 tU depleted) for the BN-600. Some 90 tU recycled supplements the RBMK supply at about 2% enrichment. This RepU arises from reprocessing the used fuel from BN, VVER-440 and marine and research reactors.

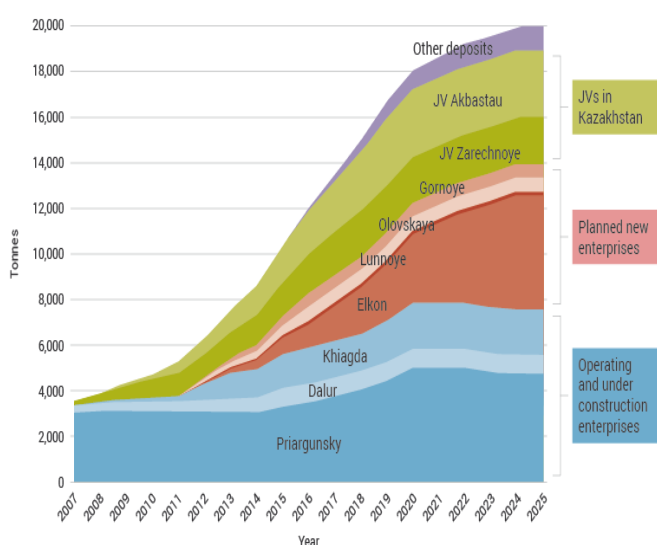
2.1. Uranium resources and mining

Plans announced in 2006 for 28,600 t/yr U3O8 output by 2020, 18,000t of this from Russia* and the balance from Kazakhstan, Ukraine, Uzbekistan and Mongolia have since taken shape, though difficulties in starting new Siberian mines makes the 18,000 t target unlikely. Three uranium mining joint ventures were established in Kazakhstan with the intention of providing 6000 tU/yr for Russia from 2007: JV Karatau, JV Zarechnoye and JV Akbastau (see below and Kazakhstan paper).

AtomRedMetZoloto (ARMZ) is the state-owned company which took over Tenex and TVEL uranium exploration and mining assets in 2007-08, as a subsidiary of Atomenergoprom (79.5% owned). It inherited 19 projects with a total uranium resource of about 400,000 tonnes, of which 340,000 tonnes are in Elkon'skiy uranium region and 60,000 tonnes in Strel'tsovskiy and Vitim'skiy regions. The rights to all these resources had been transferred from Rosnedra, the Federal Agency for Subsoil Use under the Ministry of Natural Resources and Environment.

JSC ARMZ Uranium Holding Company (as it is now known) became the mining division of Rosatom in 2008, responsible for all Russian uranium mine assets and also Russian shares in foreign joint ventures. In 2008, 78.6% of JSC Priargunsky, all of JSC Khiagda and 97.85% of JSC Dalur was transferred to ARMZ. In March 2009 the Federal Financial Markets Service of Russia registered RUR 16.4 billion of additional shares in ARMZ placed through a closed subscription to pay for uranium mining assets, on top of a RUR 4 billion issued in mid 2008 to pay for the acquisition of Priargunsky, Khiagda and Dalur. In November 2009 SC Rosatom paid a further RUR 33 billion for ARMZ shares, increasing its equity to 76.1%.

ARMZ Uranium Production Plans 2007



Source: World Nuclear Association

In 2009 and 2010 ARMZ took a 51% share in Canadian-based Uranium One Inc, paying for this with \$610 million in cash and by exchange of assets in Kazakhstan: 50% of JVs Akbastau, Karatau and Zarechnoye, mining the Budenovskoye and Zarechnoye deposits. (An independent financial advisor put the value of ARMZ's stakes in the Akbastau and Zarechnoye JVs at \$907.5 million.) Uranium One has substantial production capacity in Kazakhstan, including now those two mines with Karatau, Akdala, South Inkai and Kharasan, as well as small prospects in USA and Australia (sold in 2015). In 2013 ARMZ completed the purchase of outstanding shares in Uranium One Inc, and it became a full subsidiary of ARMZ. JSC Uranium One Group (U1 Group) is from December 2016 a 78.4% owned subsidiary of Atomenergoprom and apparently separate from ARMZ.

Following this, late in 2013 Rosatom established Uranium One Holding NV (U1H) as its global growth platform for all international uranium mining assets belonging to Russia, with headquarters in Amsterdam. It lists assets in Kazakhstan, USA and Tanzania, as well as owning and managing Rosatom's stake in Uranium One Inc. In 2013 it accounted for 5086 tU production at average cash cost of \$16/lb U₃O₈, and reported 229,453 tU measured, indicated and inferred resources (attributable share). In 2014 it produced 4857 tU and listed resources of 177,000 tU. The company plans to extend its interests into rare earths. Its 'strategic partner' is JSC NAC Kazatomprom.

ARMZ remains responsible for uranium mining in Russia. At the end of 2013 it was 82.75% owned by Rosatom and 17.25% TVEL. Exploration expenditure has nearly doubled in two years to about US\$ 52 million in 2008. In 2013 the government approved an exploration budget of RUR 14 billion (\$450 million) through to 2020, principally in the Far East and Northern Siberia. Deposits suitable for ISL mining will be sought in the Transurals, Transbaikals and Kalmykia. Other work will be in the Urals, Siberian, Far East Federal Districts (Zauralsky, Streltsovsky, Vitimsky and Vostochno-Zabkalsky, and Elkon'sky ore regions).

Rosgeologia, the Russian state-run geological exploration services company set up in 2011, has identified "promising" uranium deposits in the North-West Federal District of Russia following completion of a survey of the Kuol-Panayarsvinskaya area on the border of the Murmansk region and the Republic of Karelia. It signed an agreement with Rosatom in 2015 to focus on uranium.

CJSC Rusburmash (RBM) is the exploration subsidiary of ARMZ. VNIPIPT is the subsidiary responsible for R&D and engineering of mining and processing plants.

In December 2010 ARMZ made a \$1.16 billion takeover bid for Australia's Mantra Resources Ltd with a prospective Mkuju River project in southern Tanzania, which was expected in production about 2013 at 1400 tU/yr, but is now deferred. This is now under U1H.

2.2. Domestic mining

In 2009 the government accepted Rosatom's proposal for ARMZ and Elkon'sky Mining and Metallurgical Combine to set up the "open-type joint stock company" EGMK-Project. The state's contribution through Rosatom to the EGMK-Project authorized capital will be RUR 2.657 billion, including RUR 2.391 billion in 2009 and RUR 0.266 billion in 2010. EGMK-Project is being set up to draw up the project and design documentation for Elkon'sky Mining and Metallurgical Combine (see below).

The Russian Federation's main uranium deposits are in four districts:

The Trans-Ural district in the Kurgan region between Chelyabinsk and Omsk, with the Dalur ISL mine.

Streltsovskiy district in the Transbaikals or Chita region of SE Siberia near the Chinese and Mongolian borders, served by Krasnokamensk and with major underground mines.

The Vitimsky district in Buryatia about 570 km northwest of Krasnokamensk, with the Khiagda ISL mine.

The more recently discovered remote Elkon district in the Sakha Republic (Yakutia) some 1200 km north-northeast of the Chita region.

Present production by ARMZ is principally from the Streltsovskiy district, where major uranium deposits were discovered in 1967, leading to large-scale mining, originally with few environmental controls. These are volcanogenic caldera-related deposits. Krasnokamensk is the main town serving the mines.

In 2008 ARMZ said that it intended to triple production to 10,300 tU per year by 2015, with some help from Cameco, Mitsui and local investors. ARMZ planned to invest RUR 203 billion (US\$ 6.1 billion) in the development of uranium mining in Russia in 2008-2015. It aimed for 20,000 tU per year by 2024. Total cost was

projected at RUR 67 billion (\$2 billion), mostly at Priargunsky, with RUR 4.8 billion (\$144 million) there by end of 2009 including a new \$30 million, 500 tonne per day sulfuric acid plant commissioned in 2009, replacing a 1976 acid plant.

2.3. Russian uranium mining

Production centre	2012	2013	2014	2015	2016	2017	2018	2019
Priargunsky	2011	2133	1970	1977	1873	1631		
Dalur	529	562	578	590	591	592		
Khiagda	332	440	442	488	540	693		plan 1000
Gornoye	-	-	0					
Olovskaya	-	-	0					
Elkon	-	-	0					
Lunnoye	-	-	0					
Total	2872	3135	2990	3055	3004	2916		

Trans-Ural, Kurgan region

A modest level of production is from Dalur in the Trans-Ural Kurgan region. This is a low-cost (\$40/kg) acid in situ leach (ISL) operation in sandstones. Uksyanskoye is the town supporting the Dalur mine. ARMZ's 2008 plan had production at Dalur by acid ISL increasing from 350 to 800 tU/yr by 2019 (expanding from the Dalmatovskoye field in the Zauralsk uranium district to Khokhlovskoye in the Shumikhinsky district, then Dobrovolnoye in the Zverinogolovsky district). In 2014 JSC Dalur completed further exploration of the Khokhlovskoye deposit and increased its resources from 4700 to 5500 tonnes. Production from it is planned to increase from 50 tU in 2015 to 200 tU/yr by 2019. A mill upgrade was started in 2016. More than half of 2016 production was from the Ust-Uksyansky part of Dalmatovskoye field.

Dalur 'reserves' in 2013 were quoted by ARMZ at 9,900 tonnes. Rare earths and scandium are potential by-products. In 2016 geological exploration and pilot operations at the Dobrovolnoye deposit were completed, and a permit for development was received in June 2017, allowing construction of the plant. Its reserves are quoted as 7067 tU. After pilot operation to 2020, commercial operation is expected to maintain Dalur production at 700 tU per year to about 2025 after Dalmatovskoye and Khokhlovskoye are exhausted.

Transbaikals Chita region, Streltsovskiy district

Here, several underground mines operated by JSC Priargunsky Industrial Mining and Chemical Union (PIMCU – 85% ARMZ) supply low-grade ore to a central mill near Krasnokamensk. PIMCU was established in 1968, and produces some other metals than uranium. Since 2008 it has been an ARMZ subsidiary. Historical production from Priargunsky is reported to be 140,000 tU (some from open cut mines) and 2011 known resources (RAR + IR) are quoted as 115,000 tU at 0.159%U. In 2013 'reserves' were quoted by ARMZ at 108,700 tonnes. Production is up to about 3000 tU/yr, about one-tenth of it from heap leaching. In 2015 production was 1977 tU and costs were reduced by 11%, so that it hoped to break even in mid-2016.

The company has six underground mines, most of them operating: Mine #1, Mine #2, Glubokiye Mine, Shakhta 6R, Mine #8 with extraction from Maly Tulukui deposit, and Mine #6 (see below). ARMZ's 2008 plan called for Priargunsky's production to be expanded from 3000 to 5000 tU/yr by 2020.

Mine #1 production rate was increased in 2016. It is on the opposite side of the Oktyabrskiy settlement from mine #2 and about 2 km from it.

Mine #2 was making a loss in 2013 due to market conditions, so it was closed in order to concentrate on bringing mine #8 to full production. Stopping operations resumed in February 2015, with production target 130 tU for the year, from average grade 0.15%. It is now known as section 2 of mine #8. Some production has been exported to France, Sweden and Spain.

Mine #8 began producing in 2011, towards phase 1 target capacity of 400 t/yr by the end of 2014. The total cost of development is expected to be RUR 4.8 billion (RUR 3.5 billion for phase 1). Production was increased 22% in 2016.

Mine #6 will access the Argunskoye and Zherlovoye deposits which comprise 35% of the Streltsovskoye reserves of 40,900 tU, with much higher grade (0.3%U) than the rest. Production cost from mine #6 is projected at \$90/kgU. Future plans for Priargunsky are focused on development of mine #6.

Buryatia, Vitimsky district

JSC Khiagda's operations are at Vitimsky in Buryatia about 570 km northwest of Krasnokamensk, serving Priargunsky's operations in Chita region, and 140 km north of Chita city. They are starting from a low base – in 2010 production from the Khiagdinskoye ore field was 135 tU, rising to 440 tU in 2013 (fully utilising the pilot plant) and targeting 1000 tU/yr from 2018 with a new plant. These are a low-cost (US\$ 70/kgU) acid in situ leach (ISL) operations in sandstones, and comprise the only ISL mine in the world in permafrost. Groundwater temperature is 1-4°C, giving viscosity problems, especially when winter air temperature is -40°C. The main uranium mineralisation is a phosphate, requiring oxidant addition to the acid solution. In the Khiagdinskoye field itself there are eight palaeochannel deposits over 15 x 8 km, at depths of 90 to 280 metres (average 170 m). Single orebodies are up to 4 km long and 15 to 400 m wide, 1 to 20 m thick.

JSC Khiagda has resources of 55,000 tU amenable to ISL mining, with resource potential estimated by Rosatom of 350,000 tU, giving a mine life of over 50 years. In 2015 'reserves' were quoted by ARMZ at 39,300 tonnes U. The 2008 ARMZ plan envisaged production from JSC Khiagda's project increasing to 1800 tU/yr by 2019, but in 2013 the higher target was postponed. The 2018 plan is now 1000 tonnes. In 2014 JSC Khiagda continued construction of the main production facility and on the sulfuric acid plant, the first stage of which was commissioned in September 2015. Its final design capacity is 110,000 t/yr.

JSC Khiagda is currently mining uranium from the Khiagdin and Istochnoy deposits of the Khiagda ore field. Preparatory work for mining operations at the Vershinny deposit is under way. In May 2018, JSC Khiagda announced that engineering and geological surveys ahead of the construction of mining facilities was under way at Kolichikan and Dybryn deposits. The other two fields in the immediate vicinity are Namaru and Tetrakhskoye. All these deposits occur over an area about 50 x 20 km. There are also plans to install plant for extracting rare earth oxides (REO) as by-product. The nearest towns are Romanovka, 133 km north of Chita, and Bagdarin.

Sakha/Yakutia, Elkon district

ARMZ's long-term hope is development of the massive Elkon project with several mines in the Sakha Republic (Yakutia) some 1200 km north-northeast of the Chita region. The Elkon project is in a mountainous region with difficult climate conditions and little infrastructure, making it a challenging undertaking. Production from metasomatite deposits is planned to ramp up to 5000 tU/yr over ten years, for RUR 90.5 billion (\$3 billion), and 2020 start up was envisaged, but this is now "after 2030". Elkon is set to become Russia's largest uranium mining complex, based on resources of over 270,000 tU (or 357,000 tU quoted by Rosatom in 2015). It will involve underground mining, radiometric sorting, milling, processing and uranium concentrate production of up to 5000 tU/yr.

Elkon Mining and Metallurgical Combine (EMMC) was set up by ARMZ to develop the substantial Elkonky deposits. The Elkon MMC project involves the JSC Development Corporation of South Yakutia and aims to attract outside funding to develop infrastructure and mining in a public-private partnership, with ARMZ holding 51%. Foreign equity including from Japan, South Korea and India is envisaged, and in March a joint venture arrangement with India was announced. The Elkon MMC developments are to become "the locomotive of the economic development of the entire region", building the infrastructure, electricity transmission lines, roads and railways, as well as industrial facilities, from 2010. Of 15 proposed construction sites, three have been tentatively selected: at the mouth of Anbar River, Diksi Village and Ust-Uga Village. The building of four small floating co-generation plants to supply heat and electricity to northern regions of Yakutia is linked with the Elkon project in southern Yakutia.

There are eight deposits in the Elkon project with resources of 320,000 tU* (RAR + IR) at average 0.146%U, with gold by-product: Elkon, Elkon Plateau, Kurung, Neprokhodimoye, Druzhnoye (southern deposits), as well as Yuzhnaya, Severnaya, Zona Interesnaya and Lunnoye (see below). In mid-2010 ARMZ released JORC-compliant resource figures for the five southern deposits: 71,300 tU as measured and indicated resources, and 158,500 tU as inferred resources, averaging 0.143%U. ARMZ pointed out that the resource assessment against international standards will increase the investment attractiveness of EMMC. However, in September 2011 ARMZ said that production costs would be US\$ 120-130/kgU, which would be insufficient in the current market, and costs would need to be cut by 15-20%.

2.3. Further mine prospects

The Federal Subsoil Resources Management Agency (Rosnedra) was transferring about 100,000 tonnes of uranium resources to miners, notably ARMZ, in 2009-10, and 14 projects, mainly small to medium deposits, were prepared for licensing then. They are located mainly in the Chita (Streltsovskiy district), Trans-Ural (Zauralskiy district) and Buryatia (Vitimskiy district) uranium regions.

The projects prepared for licensing include:

Chita Oblast – Zherlovskoye, Pyatiletnee, Dalnee and Durulguevskoye.

Republic of Buryatia – Talakanskoye, Vitlausskoye, Imskoye, Tetrakhskoye, and Dzhilindinskoye.

Kurgan Oblast – Dobrovolnoye (now licensed).

Khabarovsk Krai – Lastochka.

Republic of Tyva – Ust-Uyuk and Onkazhinskoye.

Republic of Khakassia – Primorskoye.

All together these projects have 76,600 tonnes of reasonably assured and inferred resources, plus 106,000 tonnes of less-certain 'undiscovered' resources.

Rosnedra published a list of deposits in the Republic of Karelia, Irkutsk Region and the Leningrad Region to be offered for tender in 2009. In particular, Tyumenskiy in Mamsko-Chuiskiy District of Irkutsk Region was to be offered for development, followed by Shotkusskaya ploshchad in Lodeinopolsky District of Leningrad Region. In Karelia Salminskaya ploshchad in Pitkyaranskiy District and the Karku deposit were offered. None of these 2009 offerings had reasonably assured or inferred resources quoted, only 'undiscovered' resources in Russia's P1 to P3 categories and it appears that none were taken up. In 2016 the Karelia Ministry of Natural Resources and Ecology acknowledged only one uranium deposit "of no commercial interest" at Srednyaya Padma (Medvezhegorsk District) and announced that no mining was planned.

2.4. Foreign and private equity in uranium mining

In October 2006 Japan's Mitsui & Co with Tenex agreed to undertake a feasibility study for a uranium mine in eastern Russia to supply Japan. First production from the Yuzhnaya mine in Sakha Republic (Yakutia) is envisaged for 2009. Mitsui had an option to take 25% of the project, and was funding \$6 million of the feasibility study. Construction of the Yuzhnaya mine was estimated to cost US\$ 245 million, with production reaching 1000 tU/yr by 2015. This would represent the first foreign ownership of a Russian uranium mine. However, according to the 2016 Red Book, Yuzhnaya now appears to be part of the Elkon project (see above).

Following from previous deals with Tenex, in November 2007 Cameco signed an agreement with ARMZ. The two companies are to create joint ventures to explore for and mine uranium in both Russia and Canada, starting with identified deposits in northwestern Russia and the Canadian provinces of Saskatchewan and Nunavut.

In addition to ARMZ, private companies may also participate in tenders for mining the smaller and remote uranium deposits being prepared for licensing in Russia. ARMZ is open to relevant investment projects with strategic partners, and Lunnoye deposit is an example where a private company Zoloto Seligdara is partnering with ARMZ.

2.5. Conversion

Russia's total uranium conversion capacity is about 25,000 tU/yr, but only about half of this is used as of 2013.

TVEL plans to consolidate its conversion capacity at JSC Siberian Chemical Combine (SCC) at Seversk near Tomsk, where some capacity already operates. In 2012 Rosatom said it would spend RUR 7.5 billion to set up a new conversion plant at SCC Seversk, to commence operation in 2016. The new plant is designed to have a capacity of 20,000 tU per year from 2020, including 2000 t of recycled uranium. Public hearings on the project were under way in 2014. The 2015 edition of the World Nuclear Association Nuclear Fuel Report gives capacity then as 12,500 tU.

The main operating conversion plant has been at Angarsk near Irkutsk in Siberia, with 18,700 tonnes U/yr capacity – part of TVEL's JSC Angarsk Electrolysis & Chemical Combine (AECC). In anticipation of the planned new plant at SCC Seversk however, the Angarsk conversion plant was shut down in April 2014.

TVEL also had conversion capacity at Kirovo-Chepetsky Chemical Combine (KCCC) in Glazov, which was shut down in the 1990s. Since 2009 this has been a RosRAO site, for clean-up

The Elektrostal conversion plant, 50 km east of Moscow, has 700 tU/yr capacity for reprocessed uranium, initially that from VVER-440 fuel. It is owned by Maschinostroitelny Zavod (MSZ) whose Elemash fuel fabrication plant is there. Some conversion of Kazakh uranium has been undertaken for west European company Nukem, and all 960 tonnes of recycled uranium from Sellafield in UK, owned by German and Netherlands utilities, has been converted here. UK-owned recycled uranium has also been sent there.

2.6. Uranium fuel fabrication

TVEL has two fuel fabrication plants with combined capacity of 2800 t/yr finished fuel:

The huge Maschinostroitelny Zavod (MSZ) at Elektrostal 50 km east of Moscow – known as Elemash.

Novosibirsk Chemical Concentrates Plant (NCCP) in Siberia.

TVEL's Chepetsk Mechanical Plant (CMP or ChMZ) near Glazov in Udmurtiya makes zirconium cladding and also some uranium products.

Most fuel pellets for RBMK and VVER-1000 reactors were being made at the Ulba plant at Ust Kamenogorsk in Kazakhstan,

but Elemash and Novosibirsk have increased production. MSZ/Elemash produces fuel assemblies for both Russian and west European reactors using fresh and recycled uranium. It also fabricates research reactor and icebreaker fuel and in 2016 is producing the first fuel for the RITM-200 reactors in new icebreakers. VNIINM claims the fuel has greater energy density than previous icebreaker fuel.

Novosibirsk produces mainly VVER-440 & 1000 fuel, including that for initial use in China.

2.7. Regulation and safety

Two main laws govern the use of nuclear power: the Federal Law on the Use of Atomic Energy (November 1995 and Federal Law on Radiation Safety of Populations (January 1996). These are supported by federal laws including those on environmental protection (2002) and the Federal Law on Radioactive Waste Management (2011). The 1996 Federal Law on Radiation Safety of Populations is administered by the Federal Ministry of Health.

Rostekhnadzor is the regulator, set up (as GAN) in 1992, reporting direct to the President. Because of the links with military programs, a culture of secrecy pervaded the old Soviet nuclear power industry. After the 1986 Chernobyl accident, changes were made and a nuclear safety committee established. The State Committee for Nuclear and Radiation Safety – Gosatomnadzor (GAN) succeeded this in 1992, being responsible for licensing, regulation and operational safety of all facilities, for safety in transport of nuclear materials, and for nuclear materials accounting. Its inspections can result in legal charges against operators. However, on some occasions when it suspended operating licences in the 1990s, Minatom successfully overrode this. In 2004 GAN was incorporated into the Federal Ecological, Technological & Atomic Supervisory Service, Rostekhnadzor, which has a very wide environmental and safety mandate. It has executive authority for development and implementation of public policy and legal regulation in the environmental field, as well as in the field of technological and nuclear supervision. It controls and supervises natural resources development, industrial safety, nuclear safety (except for weapons), safety of electrical networks, hydraulic structures and industrial explosives. It licences nuclear energy facilities, and supervises nuclear and radiation safety of nuclear and radiologically hazardous installations, including supervision of nuclear materials accounting, control and physical protection. A 2011 overview is on IAEA website.

Safety has evidently been improving at Russian nuclear power plants. In 1993 there were 29 incidents rating level 1 and higher on the INES scale, in 1994 there were nine, and since then to 2003, no more than four. Also, up until 2001 many employees received annual radiation doses of over 20 mSv, but since 2002 very few have done so.

In 2008 Rostekhnadzor was transferred to the Ministry of Natural Resources and the Environment, but this was reversed in mid 2010 and it was brought back under direct control of the government and focused on civil nuclear energy. Following other changes in federal legislation, an IAEA Integrated Regulatory Review Service (IRRS) mission in 2013 said that Rostekhnadzor had made "significant progress" in its development since 2009 and had "become an effective independent regulator with a professional staff". Rostekhnadzor undertook to make the final IRRS report early in 2014 public.

Glavgosexpertiza, the Russian State Expert Examination Board, is the authority responsible for appraising design documentation and engineering services on behalf of the Ministry of Construction of Russia. Glavgosexpertiza ensures compliance of all major infrastructure construction projects with national technical regulations and statutory requirements.

Rosprirodnadzor, the Federal Service for Supervision of Natural Resources needs to give environmental approval to new projects, through its State Environmental Commission.

2.8. Exports:

fuel cycle

Soviet exports of enrichment services began in 1973, and Russia has strongly continued this, along with exports of radioisotopes. After 1990, uranium exports began, through Technobexport (Tenex). At 2015 Atomexpo it was announced that at the start of the year Rosatom's foreign portfolio totaled US\$ 101.4 billion, of which \$66 billion was reactors, \$21.8 billion was the contracted sales of EUP and SWU, and the remaining \$13.6 billion was attributable to the sales of fabricated fuel assemblies and uranium. Rosatom's goal is to gain half its revenue from exported goods and services.

Tenex expects to increase its share in the global market for front-end fuel cycle services to 40% by 2030, assisted by offering an 'integrated product' covering the entire nuclear fuel cycle, and to contribute up to half of Rosatom's foreign currency revenue. Tenex revenue in 2014 was over \$2.2 billion, and forward orders totalled almost \$23 billion, including almost \$6 billion in over 20 contracts with US utilities for enriched uranium product. Tenex sees the Asia-Pacific market as a growth area, using a new transport route through Vostochny Seaport, Primorye Territory.

In 2009 Tenex signed long-term enrichment services contacts with three US utilities – AmerenUE, Luminant and Pacific Gas & Electric – and one in Japan – Chubu. The contracts cover supply from 2014 to 2020. Then it contracted to supply enriched uranium product over the same period with Exelon, the largest US nuclear utility. By the end of 2010, the value of contracts with US companies rose to about \$4 billion, beyond the diluted ex-military uranium already being supplied to 2013 from Russian weapons stockpiles. In 2012, Tenex supplied about 45% of world demand for enrichment services and 17% of that for fabricated fuel. It exported fuel for 34 reactors as well as supplying 33 Russian ones.

general, plants and projects

Russia is engaged with international markets in nuclear technology, well beyond its traditional eastern European client states. An important step up in this activity was in August 2011 when Rosatom established Rusatom Overseas company, with authorized capital of RUR 1 billion. In mid-2015 it was split into JSC Rusatom Overseas Inc. and JSC Rusatom Energy International.

Rusatom Overseas Inc is responsible for implementing non fuel-cycle projects in foreign markets, though apparently it also promotes products, services and technologies of the Russian nuclear industry generally to the world markets. According to Rosatom, "Rusatom Overseas acts as an integrator of Rosatom's complex solutions in nuclear energy, manages the promotion of the integrated offer and the development of Russian nuclear business abroad, as well as working to create a worldwide network of Rosatom marketing offices." Rusatom Overseas planned to open some 20 offices around the world by 2015, as a market research front and shop window for all Rosatom products and services.

Rusatom Energy International acts "as a developer of Rosatom's foreign projects, which are implemented with the build-own-operate (BOO) structure" and is a shareholder in those project companies. One of the first projects that Rosatom is implementing using the BOO structure is the Akkuyu plant in Turkey. A second project is Hanhikivi in Finland.

At 2015 Atomexpo it was announced that at the start of the year Rosatom's foreign portfolio totaled US\$ 101.4 billion, of which \$66 billion was reactors, \$21.8 billion was the contracted sales of EUP and SWU, and the remaining \$13.6 billion was attributable to the sales of fabricated fuel assemblies and uranium. The total at the end of 2015 was over \$110 billion, and export revenues in 2015 were

\$6.4 billion, up 20% from 2014. Rosatom's goal is to gain half its revenue from exported goods and services. Its long-term strategy, approved by its board in late 2011, calls for foreign operations to account for half of its business by 2030. It aims to hold at least one-third of the global enrichment services market by then, as well as 5% of the market for pressurized water reactor (PWR) fuel. The corporation said that it is "actively strengthening its position abroad for the construction of nuclear power plants." In April 2015 Rosatom said that it had contracts for 19 nuclear plants in nine countries, including those under construction (5). In September 2015 it said it had orders for 30 nuclear power reactors in 12 countries, at about \$5 billion each to construct, and it was negotiating for 10 more. It said that the total value of all export orders was \$300 billion. It aims to have orders for the construction of some 30 power reactors outside of Russia by 2030.

International collaboration

Russia is engaged with international markets in nuclear energy, well beyond its traditional eastern European client states. In June 2011 Rosatom announced that it was establishing Rusatom Overseas company, a new structure to be responsible for implementing non fuel-cycle projects in foreign markets. It could act as principal contractor and also owner of foreign nuclear capacity under build-own-operate (BOO) arrangements. It is vigorously pursuing markets in developing countries and is establishing eight offices abroad.

President Putin's Global Nuclear Infrastructure Initiative was announced early in 2006. This is in line with the International Atomic Energy Agency (IAEA) 2005 proposal for Multilateral Approaches to the Nuclear Fuel Cycle (MNA) and with the US Global Nuclear Energy Partnership (GNEP). The head of Rosatom said that he envisages Russia hosting four types of international nuclear fuel cycle service centres (INFCCs) as joint ventures financed by other countries. These would be secure and maybe under IAEA control. The first is an International Uranium Enrichment Centre (IUEC) – one of four or five proposed worldwide (see separate section). The second would be for reprocessing and storage of used nuclear fuel. The third would deal with training and certification of personnel, especially for emerging nuclear states. In this context there is a need for harmonized international standards, uniform safeguards and joint international centers. The fourth would be for R&D and to integrate new scientific achievements.

In March 2008 AtomEnergProm signed a general framework agreement with Japan's Toshiba Corporation to explore collaboration in the civil nuclear power business. The Toshiba partnership is expected to include cooperation in areas including design and engineering for new nuclear power plants, manufacturing and maintenance of large equipment, and "front-end civilian nuclear fuel cycle business". In particular the construction of an advanced Russian centrifuge enrichment plant in Japan is envisaged, also possibly one in the USA. The companies say that the "complementary relations" could lead to the establishment of a strategic partnership. Toshiba owns 77% of US reactor builder Westinghouse and is also involved with other reactor technology.

Regarding reactor design, Rosatom has said it is keen to be involved in international projects for Generation IV reactor development and is keen to have international participation in fast neutron reactor development, as well as joint proposals for MOX fuel fabrication.

3. Conclusions:

1. There are large uranium reserves in the Russian Federation, which represents more than 10% of the world's reserves, there are new promising areas that are testing the territory and developing uranium mines;

2. ARMZ is one of the largest operators in the world for the extraction of uranium and it has assets and owns many foreign

enterprises of the mining industry. Russia is among the leading countries in the processing of uranium and is one of the key players in the global market for nuclear fuel and nuclear materials.

3. Russia's total capacity for uranium conversion is about 25,000 tons / year, but only about half of this volume is used as of 2016. TVEL has two fuel production plants with a total capacity of 2,800 tons / year of finished fuel. It supports more than 80 nuclear power plants in Russia and abroad with fuel;

4. Russia is a nuclear-weapon state and the depositary state of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), in accordance with which the safeguards agreement has been in effect since 1985. The Additional Protocol was ratified in 2007. Safety at Russian nuclear power plants is obviously improving. Significantly higher is the maintenance personnel's skill and regulatory requirements for processing and preservation.

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PREPARATION OF THE SOCIETY AGAINST CRISIS AND WAR – BASIC ASPECTS

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Abstract: Social security is an essential element ensuring the proper functioning of the national security system in the state. In order to fulfil this task, the state adequately prepares the society through education for safety and provides training in the field of universal self-defence of the population in order to prepare citizens in the event of crisis and war. The article presents only issues concerning education for safety and universal self-defence of the population.

Keywords: NATIONAL SECURITY, SOCIAL SECURITY, EDUCATION FOR SAFETY, TRAINING THE POPULATION IN SELF-DEFENCE.

1. Introduction

Nowadays, the aspiration of every state is to provide broadly understood security¹, which is influenced by many interrelated factors, both internal and external. Current security conditions include variability, unpredictability and surprise², with which most of current security threats are connected, because they concern both internal threats (e.g. natural disasters are unpredictable) and external ones (e.g. all actions of terrorist groups characterize these three features). The whole security is affected by various factors, which is why we can speak about, among others, military, ecological, energy, economic, political, cultural, social and information security. The individual types of security depend on each other, therefore, when thinking about any security, all aspects should be taken into account³. When considering security-related issues, it should be remembered that security is not only a state obtained as a result of the activities of various entities, but also a continuous process due to the changing threats of the modern world, the situation on the international arena.

The issue of this article is related to social security and precisely to the preparation of society for functioning in conditions of danger, crisis and war.

In conclusion, the essence of national security⁴ is persistence, survival of the society in crisis conditions and development in favourable conditions, as well as risk taking in situations of all threats.

Social security⁵ being an element of national security, is to ensure the conditions for a dignified life of citizens and the development of the entire nation (spiritual and material), as well as

ensure the protection of national heritage. It includes:⁶ protection and strengthening of national identity, operation of the media for security, counteracting threats to demography, ensuring social security and education for safety (fig. 1).



Fig. 1. Structure of the Social Security System. Own study based on: National Security Strategy of the RP 2014.

1. Education for safety⁷

The issue includes activities aimed at acquiring knowledge and skills by the citizens in the area of security, increasing their competence in this area and strengthening social awareness of security threats and proper response in the event of their occurrence. It is implemented by general and higher education, central and local state institutions as well as associations and non-governmental organizations⁸, which must cooperate together.

The Act on the general duty of defence of the Republic of Poland determines who is subject to the obligation of education for safety, these are: [Primary school and secondary school students; general high school, technical school and industry school of the 1st

¹ Security is: "a state of non-threat, peace, confidence"- J. Stańczyk, *Contemporary understanding of security*, ISP PAN, Warsaw 1996, p. 15; Security – "a state that gives you confidence and guarantees its maintenance and a chance for improvement. One of the basic human needs is a situation characterized by a lack of risk of losing something that a person particularly values, for example: health, work, respect, feelings, material goods"- Ed. J. Pawłowski, *Dictionary of terms in the field of national security*, AON, Warsaw 2009, s. 13.

² See J. Marczak, *National Security – concept, character, determinants* [in] *Foundations of national security in the era of globalization*, ed. R. Jakubczak, AON, Warsaw 2008, p. 34-39

³ See A. Skrabacz, S. Sulowski, *Social security. Concepts, conditions, challenges*. Elipsa, Warsaw 2012, p.14.

⁴ Security began to be described and researched in this subject as an antidote to the emergence of new (non-military) threats in the 1980s, previously only military strikes were recognized. Author's footnote.

⁵ "Social security covers all legal and organizational activities carried out by governmental entities (national and international), non-governmental organizations and citizens themselves, which aim at providing a certain standard of living for individuals, families and social groups and preventing their marginalization and social exclusion"- M. Leszczyński, *Social security and state security*, Publication of the Jan Kochanowski University of Humanities and Natural Sciences, Kielce 2009, p. 37; "Social security means protecting the existential basis of human life, providing opportunities to satisfy individual needs (material and spiritual) and performance of life aspirations by creating conditions for work and study, health protection and pension guarantees"- A. Skrabacz, *Social security, Theoretical and practical basics*, Publishing House Elipsa, Warsaw 2012, p. 38.

⁶ National security strategy from 2014, p. 38;

⁷ Ibidem, p. 39; The subject of "Education for safety" was introduced to Polish school from September 1, 2009, replacing the subject of "Protective Prevention". The scope of education within the framework of "Education for safety" includes issues concerning: state security, preparation for rescue operations in the event of various threats, principles of first aid and health education – Author's footnote.

⁸ National security strategy from 2014, p. 39.

degree, with the exception of adult school students, are subject to education for safety]⁹. In addition, the Act specifies that the subject “Education for safety” is mandatory for the above-mentioned schools and covers one hour per week.

The ordinance of the Minister of National Education¹⁰ sets out in detail the goal and assumption of the subject “Education for safety”, stating that it is to prepare students for appropriate, proper responses to dangerous situations, according to the scale of the threat, and presents content regarding rescue operations, first aid and individual and collective health-related issues. In addition, the subject takes into account issues concerning state security including the essence of security, safety components, its determinants and the role of international organizations in ensuring security. The curriculum is based on the core curriculum of the subject: education for safety. It consists of four modules: state security, threats in the modern world and dealing in emergency situations, first aid in emergency states threatening life, health education (fig. 2).

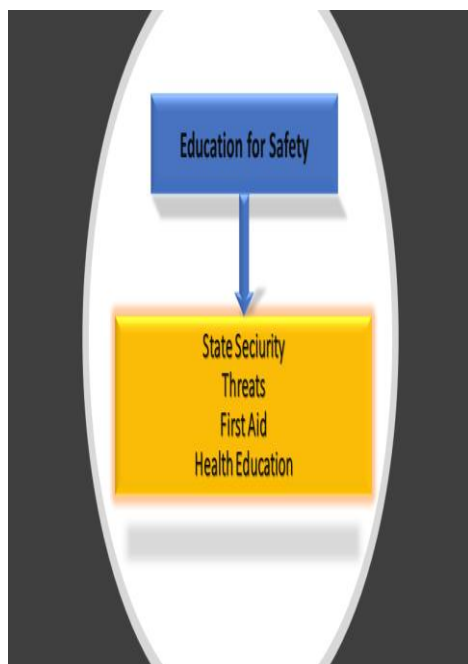


Fig. 2. Education for safety. Own study based on: Regulation of the Minister of National Education of February 14, 2017

State security

Security is the basis for the functioning of every state and allows its stable development. The defence system of the state consists of many links that must cooperate together and complement each other. Therefore, it is necessary to know the geopolitical conditions of Poland's security, the importance of international organizations in shaping security.

Threats in the modern world, dealing with threats

⁹ The Act of November 21, 1967 on the general obligation to defend the Republic of Poland (Journal of Laws of 1967 no. 44, item 220 and Journal of Laws of 2018, item 1459, 1669), art. 166.1.

¹⁰ See the Regulation of the Minister of National Education of February 14, 2017 on the core curriculum of pre-school education and the core curriculum of general education for primary school, including students with intellectual disability of a moderate or severe degree, general education for a special school of the 1st degree, general education for a special school preparing for work and general education for a post-secondary school (Journal of Laws of 2017, item 356).

Issues of this module will familiarize students with the threats of various origins (natural and man-made) occurring in the modern world, allow to recognize alarm signals, warning messages in force in the state and also learn the rules of conduct in case of alarm signals. They teach how to respond in crises at home, at school and the surrounding area. They allow to get to know the role and tasks of services responsible for participation in the elimination of threats (fire, traffic accidents, snowstorms, release of dangerous chemicals, terrorist incidents).

First aid in sudden life-threatening situations

The subject of this module contains a very wide range of issues regarding first aid, safe conduct at the place of event (protection of one's own health, assessment of own capabilities, use of personal protection measures), recognizing the life threatening condition of the injured person, the ability to deal with the unconscious person (among others, assessment of respiratory function and possible airway clearance, correct positioning of the unconscious person in the lateral position, thermal protection of the person). In addition, the module teaches proceedings in the case of people with limb injuries, burns, cardiac arrest, choking and others. Knowledge, skills achieved under this chapter can be used in various types of threats involving persons injured.

Health education. Health in an individual and collective dimension

Issues included in this module allow to get to know the factors and behaviours that threaten health, or act positively on people, and also indicate tasks that can contribute to improving health (among others, protection of the natural environment, cooperation of people, organizations for health).

2. Training in the field of universal self-defence of the population

Activities aimed at preparing the population for universal self-defence consist in its participation in training and the performance of specific obligations by citizens. Legal regulations concerning activities within this field can be found in: Act of November 21, 1967, on the general obligation to defend the Republic of Poland (section IV, chapter 4 – Common self-defence of the population) and in the Regulation of the Council of Ministers of September 28, 1993 on universal self-defence of the population. Universal self-defence as part of civil defence consists of compulsory participation of the population in basic or practical exercises (practical exercises can be carried out in the framework of combating natural disorders and environmental threats, as well as during removal of their consequences).

The Act on the general duty to defend the Republic of Poland includes the following provisions concerning this issue:¹¹ [Persons with the Polish citizenship, capable in terms of health, subject to the obligation to train the population in the field of universal self-defence. Training of the population in the field of universal self-defence aims to prepare for self-defence against the means of mass destruction and other actions of the enemy. Training of the population in the field of universal self-defence is carried out in the form of basic classes or practical exercises]. According to the provisions of the aforementioned Act, Polish citizens up to 60 years of age are obliged to self-defence, the exception being: sick persons, incapable of work, disabled, taking care of children under 16, pregnant women, soldiers of active service and officers of the services, guards responsible for security in the state (Internal Security Agency, Intelligence Agency, Police, Central Anticorruption Bureau, Border Guard, State Protection Service, Prison Service and State Fire Service). The duties imposed on

¹¹ Act of November 21, 1967 on the general obligation to defend the Republic of Poland (Journal of Laws of 1967, no. 44, item 220 and Journal of Laws of 2018, item 1459, 1669), § 168.

citizens within the framework of universal self-defence include: preparation of protection of residential premises, personal and individual property, protection of own sources of drinking water against pollution and contamination, maintenance of appropriate equipment and means of protection in a proper state.

The document in detail specifying the size, organization and principles of training the population in the field of universal self-defence and defining the competence of the authorities in matters of imposing this obligation and releasing it is the regulation of the Council of Ministers of September 28, 1993 on universal self-defence of the population.

Training in the field of universal self-defence consists of compulsory participation of people in basic or practical exercises.

Basic classes, are organized in the form of training or self-education, their task is to theoretically prepare the population to perform self-defence tasks. They are carried out in a five-year cycle, not more often than twice a year (on business days up to 4 hours or up to 8 hours on a non-working day). They are implemented on the basis of programs elaborated by commune administrators, mayors (presidents of cities) of programs, which take into account the program assumptions of the Head of National Civil Defence and the issue of threats of a given region, plant or environment, rules of conduct in cases of their appearance, assistance to the injured. The discussed classes conducted by civil defence instructors, commanders of the civil defence formation or other persons appropriately prepared for this are held in workplaces or in places of residence.

During **practical exercises**, projects are carried out that give the opportunity to acquire practical skills to protect own health and life, household and help the injured.

[The organization of training of the population in the field of universal self-defence is directed by the competent civil defence chiefs using the existing database of the civil defence formation for this purpose]¹².

Participation in training in the field of universal self-defence is mandatory, imposed on citizens in the form of a decision issued by the commune administrator or mayor (city president). People who were established under the said decision are required to attend training in the field of universal self-defence in the time and place indicated by the organizer of the training. There is a possibility of appeal against the decision, the appeal may be at the request of the person concerned or from the office (e.g. due to the position held – significant for reasons of national security) after presenting the documents justifying the application. Exemptions from the obligation to undergo training in the field of universal self-defence are carried out by commune administrators or mayors (city presidents).

Commune administrator, mayor (city president) by imposing the obligation on the citizens to prepare for self-defence defines the principles of preparing buildings for protection, proceedings after the announcement of alarm signals and during natural disasters and other threats, as well as controls the preparation of self-defence.

The head (owner) of the workplace (in relations to the employees of the plant), commune administrator or mayor (city president) are obliged to keep records of persons subject to training in the field of universal self-defence and persons who have been trained.

Expenses related to the training of the population in the scope of universal self-defence constitute the costs of the state budget as part of current expenditure for defence purposes.

4. Conclusions

The presented analytical material concerns a very important social problem, which is the proper preparation of the population of the state to act in the event of crisis or war. Knowledge of this problem by young people under education and adult citizens can make a significant contribution to surviving in difficult crises. The idea of implementing the subject "Education for safety" with its program assumptions is a very good idea, but it does not always work well in practice due to the lack of fully prepared, specialized, educating staff.

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¹² Regulation of the Council of Ministers of September 28, 1993 on universal self-defence of the population (Journal of Laws of 1993, no. 91, item 421) §3.

CHEMICAL, BIOLOGICAL, RADIOLOGICAL AND NUCLEAR THREATS IN THE HYBRID WAR CONTEXT

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Abstract: The report examines the security environment in recent years in both NATO and the Republic of Bulgaria, the challenges they face as a result of international terrorism and, in general, from hybrid threats. The natures of the hybrid threats and the guidelines for limiting and overcoming them have been examined.

Keywords: CBRN, HYBRID WAR

1. Introduction

The modern challenges to prosperity and peace are seriously changing the security environment. In recent years, the scale and complexity of conventional and unconventional threats to peace and security have emerged, including low-intensity asymmetric conflicts, global terrorism, piracy, transnational organized crime, resource and critical infrastructure security, threats of increasing arms proliferation opportunities Weapons of Mass Destruction (WMD), which have been identified by NATO as hybrid threats. Major challenges for security and defence systems related to them are the emergence of new hybrid threats; the unimpeded and relatively inexpensive emergence of new entrants with regional and global capabilities ranging from elements of traditional armed forces to individual groups whose predictability of behaviour is small.

The Islamic State (DAESH) has prompted Alliance to take action on the most rigorous opposition to these new and diverse hybrid threats. NATO faces a period of persistent instability which coming from the Middle East. Powerful non-state armed groups continue to destroy existing state structures in this area and create many problems leading to mass migration of large groups of the population of these countries. The rise of DAESH is most significant of these new threats from terrorist organization which there are Syria and Iraq. The rapid advance of DAESH in Iraq in 2014 and the gained control of large areas of Syria and Iraq led to a massive humanitarian crisis and mass emigration of large populations of these two countries.

The main response to hybrid threats or attacks is within the sphere of the particular nation state as any defence or security challenge. Cooperation on a multilateral basis is also essential. As a part of the planning of the response to hybrid threats, nations can turn on the Allies and the general public for help, which should be coordinated by the host national authorities and aligned with their national plan to counter the challenges facing them they are upright.

2. The key role of CBRN hazards in the hybrid war.

Hoffman's ideas about hybrid warfare gained traction within the U.S. defence community, and several other military theorists expounded upon these ideas. Colonel Jeffery Cowan continues the discussion in his monograph "A Full Spectrum Air Force" in which he outlines the spectrum of conflict as envisioned by the defence analyst Shawn Brimley. [1] Brimley's model includes low-end insurgent tactics and limited technology such as nuclear weapons, bombers and aircraft carriers on the other end. In this model, modern conventional militaries attempt to cover the middle and higher end of the spectrum to guard against most likely threats. Cowan explains the model in the terms of hybrid warfare by arguing that the pressures of globalization allow potential hybrid threats to gain access to conventional military capabilities that normally reside closer to the middle of the spectrum through the use of global finance and the available proliferation of information the technology. Examples include air defence systems such as the rocket propelled grenade and the Kornet Antitank Missile, both used by Lebanese Hezbollah in the 2006 War against Israeli Defense Forces. [2] He then explains that the globalization and the proliferation of weapons of mass destruction (WMD) technology-defined as nuclear, biological, chemical, radiological and high explosive-have bent the high end of the spectrum toward the middle as non-state actors such as terrorists and hybrid threats complete with some Second and Third World nations to gain access to this end of the spectrum through the use of money and acquisition of available means such as technical knowledge and equipment.

Biological weapons can be produced from widely available pathogens that are manufactured for legitimate biomedical research or obtained from soil or infected animals and humans. In fact, many of the infectious diseases that are associated with biological warfare are endemic to the same countries that are most often suspected of trying to develop biological weapons. And because biological agents may be cheap and easy to obtain, any nation with a basic industry or facility such as a brewery has a de facto capability to produce biological weapons. [3]

The longstanding efforts of the international community writ large have to exclude weapons of mass destruction (WMD) from international competition and conflict. The proliferation of these weapons is likely to be harder to prevent and thus potentially more prevalent. Nuclear weapons are likely to play a more significant role in the international security environment, and current constraints on the proliferation and use of chemical and biological weapons could diminish. There will be greater scope for WMD terrorism, though it is not possible to predict the frequency or severity of any future employment of WMD. New forms of WMD—beyond chemical, biological, radiological, and nuclear weapons—are unlikely to emerge in the Hybrids war.

Technological don't be provide to the covert development of nuclear weapons and to the development of more sophisticated nuclear weapons. Chemical and biological weapons (CBW) are likely to be:

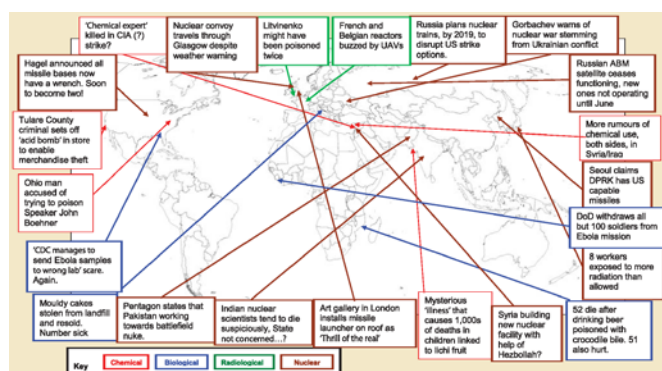


Fig. 1 Global CBRN treats and activity. [6]

1) More accessible to both state and nonstate actors due to lower barriers to the acquisition of current and currently emerging CBW technologies;

2) More capable, particularly in terms of their ability to defeat current or currently emerging defensive countermeasures;

3) More discriminate; that is, more precisely targeted and/or more reliably low- or nonlethal;

4) Harder to attribute (utilizing hitherto unknown agents and/or delivery mechanisms) than the traditional forms known today.

No major new technological developments regarding the radiological weapons are foreseen. Some types of CBR weapons can be employed to inflict discrete effects while conventional weapons can be employed in ways that are massively destructive. Radiological weapons are now seen as the most likely to cause relatively localized effects. Many biological and chemical agents can be used in highly discriminate ways, including assassinations, and some chemical and biological agents such as foot and mouth disease may be useful mainly for disruption. Moreover, different types of WMD can have different political-military effects.

More countries are likely to cleave to or seek out the perceived security of nuclear weapons in this more uncertain environment, and some may test the political and military utility of new biological and chemical weapons capabilities made possible by technological developments, especially in the life sciences. There will be greater scope for WMD terrorism. Of particular concern will be how the diffusion of WMD technologies will increase the capacity of small groups and even lone actors, whose motivations and actions are inherently less subject to prediction and control, to acquire and employ the technologies of mass destruction even if done inadvertently. [5]

3. Countering CBRN hazards in the hybrid war.

Hybrid strategies requires successful countering of Allies and NATO as a whole to be able to recognize, identify and resist hybrid actions in a timely and adequate manner. The processes that enable rapid assessment of the situation and decision-making are facilitated. However, in order for this to be done, member states and the Alliance as a whole must possess and develop the necessary capabilities to enable them to respond effectively. While NATO's primary objective is to demonstrate Allied and Alliance action for recognition, resilience, readiness and rapid decision-making to deter hybrid attacks and avoid escalation, each member state and NATO as a whole able to respond to any form of hybrid attack, including by military force in the event of a military conflict. This requires considerable effort to coordinate the actions of both parties - the member states and NATO itself.

There are three functions of preparation, containment and defence, which is following by the NATO, must ensure that the Allies are prepared to resist hybrid attacks in any form and limit the impact of any hybrid attack on the Alliance.

NATO-EU collaboration on CBRN threats and the potential impacts of WMD use is focused through collaboration between the NATO Joint CBRN Defense Centre of Excellence and the EU CBRN Centre of Excellence. The organizations work closely together to integrate crisis response, training capabilities, and threat analyses - still, more can certainly be done.

Close interactions between the NATO CBRN Task Force and EU CBRN Centre of Excellence are a good starting point for the establishment of more formal cooperative frameworks for protecting dual-use materials, monitoring terrorist activities, and developing joint threat assessments. NATO and the EU, however, could further enhance cooperation within the framework of the DAT and SPS programs to coordinate and develop the CT capabilities of EU agencies Europol and Frontex. This partnership could work to integrate and coordinate best practices for countering non-conventional threats. In addition, focus on counter-WMD

capabilities, dual-use, or conventional weapons proliferation, criminal networks trafficking, and border and maritime security could help secure European ports, airports, cities, and other critical infrastructure. [4]

Shared situational awareness is another key area of NATO-EU cooperation on counterterrorism, which flows directly from the above. Intelligence sharing between the two organizations, however, is currently limited to informal information exchange between specific NATO and EU agencies and centers of excellence. Thus, collaboration between NATO, Europol, Frontex, and the EU cyber and CBRN centers of excellence remains one of the most important means of sharing information concerning terrorist threats between NATO and the EU. [4]

The analysis of the nature and scale of the CBRN threats and the feasibility of terrorist acts using radioactive, chemical and biological agents leads to the conclusion that CBRN hazards are an objective reality that exists both in the event of a crisis or conflict and in peacetime. The necessary capabilities for their timely detection, identification and warning of the Bulgarian armed teams in order to ensure their safety and conditions for the accomplishment of assigned tasks. The Bulgarian defense policy is key to defining structure, functions, requirements to required level of standardization for warning and reporting CBRN system. Achieving interoperability and ensuring its integration into the overall NATO warning and reporting system requires aligning it with the Alliance's core documents - the AJP Joint Allied Doctrine of AJP - 3.8 and the tactical doctrine of ATP - 45. This is what the basic requirements with regard to the system structure, the reporting and warning procedures for an emerging CBRN event and the necessary capabilities for detection, identification and monitoring.

The current system improve for clarifying and assessing the CBRN environment can be achieved by automating the detection, detection and warning of endangered objects.

4. Conclusion

Hybrid threats create a unique challenge for NATO member states as well as the Republic of Bulgaria. Strongly resilient to unilateral approaches, hybrid threats react to any counteraction by applying tactics, techniques and procedures other than traditional conventional methods used in the past century. The sustainability of all elements of the hybrid threat requires improved collective defense. Only the effective implementation of military and non-military methods and instruments will be able to counteract these new threats.

Hybrid threats, characteristics specificities, complexity of the challenges and multi-facets of their manifestation as well as the variety of implications for operational capabilities and their build-up for timely and effective response will continue to rank among the major challenges for security and defense systems of modern society.

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