Tires and machinery universal Proving Ground in extreme climatic conditions of Yakutia

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Abstract. This article considers an investment project of creation of a universal proving ground for automobile tires and transport systems in extreme natural and climatic conditions of operation. It is planned to conduct studies of reliability of transport machinery and equipment in Yakutia, in the coldest habitable part of the planet.

1. Introduction
Automobile industry and companies producing the transport machinery carry out tests of their products before starting production. Depending on a development stage, new models are tested for an entire planned life cycle, including in the extreme climatic conditions in order to confirm or deny one or another technical statement [1].

The development of the production of automobiles and its components (tires, transmission units and brake systems) has become strictly regulated by technical and operational requirements that determine perfection of constructions by dynamic, economic, ergonomic and other indicators. Along with this, the requirements of rationalism and creation of promising models are a basis for an automobile design [2].

To improve technical characteristics of the transport systems, the ground tests as close as possible to the natural operating conditions are required. At present, due to the active development of new territories of the North-East of Russia, as well as Arctic and subarctic zones, the operational reliability of the transport machinery, technologies and their systems becomes relevant [3, 4].

An aspiration of participation of higher educational institutions and specialized research centers in a process of the technological development of economic entities as well as regions located in an area of zoning of the Arctic can be achieved by introduction of innovative measures conducted by the specialized test proving grounds in the extremely low climatic conditions and in the cryolithozone area.

In 2017, on the basis of the Faculty of Road Construction of the North-Eastern Federal University (NEFU), a decision was made to create the innovative project of building of the universal proving ground for the automobile tires and transport machinery in the city of Yakutsk. For this project, a small innovative enterprise “NEFU Proving Ground LLC” was established. The main goal of the project was the building of the universal proving ground in the territory of priority social and economic development (TPD) “Industrial Park “Kangalassy”” [5].

The TPD “Industrial Park “Kangalassy”” is a multi-purpose industrial and business site. The Far East Development Corporation together with the Government of the Republic of Sakha (Yakutia) and the
administration of the urban district "the city of Yakutsk" actively work to create an infrastructure and to develop the manufacturing enterprises on their sites [6].

It is important to note that at some time in the past, Head of the District Administration of the city of Yakutsk A.S. Nikolayev made a decision to allocate a land plot for the construction of the new NEFU proving ground in the region of Kapitonovka with an area of 72 ha. The Rector of NEFU, Head of the District Administration of the Yakutsk city, the Director of the “Industrial Park “Kangalassy”” approved a Plan of measures (a Roadmap) for implementation of the project of the construction of the Proving ground of automobile tires in the territory of priority social and economic development (TPSED) “Kangalassy” for 2017-2020 of 11.05.2017. A certificate was received certifying registration of a legal entity as a resident of the territory of priority social and economic development from the JSC “Far East Development Corporation” of 03.04.2018, also there is Agreement №1/P-152 on the implementation of activity in the territory of priority social and economic development with the Joint Stock Company “Far East Development Corporation” [7].

2. Materials and methods

Complex of the proving ground include:

- Site 1 “Proving ground” has the proving ground with the technical center.
- Site 2 “Kapitonovka” has a garage of special machines and the center of maintenance service of machines (Figure 1).

![Figure 1. Planned location of proving ground in area of Kangalassy village (site “Proving Ground”).](image)

The Kangalassy village is located in the northern part of the administrative territory of the city at a distance of 43.6 km, journey time from the city center is 50 minutes. There is a riverside wharf for ships of a “river-sea” class, suitable for handling industrial cargos including raw materials and finished goods. The International Airport “Tuymaada” and Yakutsk River Port are located 25-35 km away. The “Yakutsk-Namtsy” highway is 10 km away, the village is connected to the city of Yakutsk by the regular bus service [8].

During the implementation of the project with obtainment of a resident status, a land plot of 0.5 ha was provided for the construction of the objects of the test complex: the “Center of maintenance service of machines” and “Garage of special machines” for purposes of the scientific, educational and production activity (site 2 “Kapitonovka”).
The construction of test tracks is carried out on the 72 ha land plot provided by Yakutsk city Administration located in close proximity to the “Industrial Park”.

The initiator of the project carried out land cadastral works (topographical survey, formation of the land plot, inclusion in the cadastral plan, correction of a land category). Currently, the land plot has the following characteristics:

- The cadastral number is 14:35:000000:3908.
- The land category is the lands of settlements (the lands of inhabited localities) for provision of the scientific activity.
- The area is 722857 m².

The proving ground is the motor road including different test tracks with different types of road surfaces, slopes and turns.

Composition of the objects of the test complex:
- proving ground (site 1 “Proving Ground”);
- garage of special machines (site 2 “Kapitonovka”);
- technical center (site 1 “Proving Ground”);
- center of maintenance service of machines (site 2 “Kapitonovka”).

Table 1. Technical and economic parameters: center of maintenance service of machines and garage of special machines (site 2 “Kapitonovka”)

| No. | Parameter                                      | Value     |
|-----|-----------------------------------------------|-----------|
| 1   | The building area                             | 578.22 m² |
| 2   | Fill under the building                       | 196.7 m²  |
| 3   | The structural volume                         | 1804.02 m³|
| 4   | The total area                                | 306.96 m² |
| 5   | The building area                             | 309.97 m² |
| 6   | The structural volume                         | 1207.13 m³|
| 7   | The total area                                | 232.60 m² |
| 8   | The building area                             | 268.25 m² |

Figure 2. Explanation of buildings and structures on site 2 “Kapitonovka”. 
Table 2. Technical and economic parameters: technical center (site 1 “Proving Ground”).

| No. | Parameter                                    | Value       |
|-----|----------------------------------------------|-------------|
| 1   | The building area                           | 194.1 m²    |
| 2   | The area of driveways and turn-around sites | 786.5 m²    |
| 3   | The fence length                            | 171.0 m     |
| 4   | The number of gates                         | 2 pcs       |
| 5   | The structural volume                       | 460.06 m³   |
| 6   | The total area of the building              | 126.1 m²    |
| 7   | The usable area                             | 111.12 m²   |
| 8   | The calculated area                         | 96.85 m²    |

The construction works of the proving ground include:
- a layout and planning of the motor road;
- excavation, transportation, development and compaction of soil;
- topping of the road from a sand and gravel mix (SGM);
- installation of a fence, mount of road signs and metal posts;
- The proving ground in the standard design includes 6 different tracks: 80x30 m, 600x30 m (ice), 1000x70 (speed), 1842x5 m, 1690x5 m, 830x5 m.

Figure 3. Facade of technical center.

Figure 4. Scheme of proving ground.
The estimated area of the proving ground with the technical center in the territory of the lands allocated by the administration of Yakutsk (the site “Proving ground”) is 722857 m².

The main technical parameters for the projected section of the road were accepted according to Set of Rules 34.13330.2012 “Roads. Planning and development of local roads”:

- the estimated speed of motion is 40-60 km/h;
- the lane width is 5 m;
- the number of lanes is 1;
- the type of the road topping is lightweight;
- a roadway cover kind is the SGM (the sand and gravel mix).

![Typical transverse profile of roadway](image)

**Figure 5.** Typical transverse profile of roadway

### 3. Results and discussion

As of 01.03.2019, the large organizational, preparatory and construction works had been carried out, in particular:

The organizational and preparatory works are: a marketing study of the market of the winter car tires in the Russian Federation and comparative analysis of the climatic conditions were conducted, a space and topographical survey of the land plot (72 ha) was performed. The business plan of the project was developed, the complex engineering surveys (engineering and geodetic, engineering and geological, engineering and ecological) of the site “Kapitonovka” were conducted, design and estimate documentation of the project was developed [9-11].

The general construction works are: they have been completed at the “Center of maintenance service of machines” object, external gas and water supply networks have been installed. There are accomplished sets of finishing, electrical and plumbing works and the installation of a fire alarm system.

The road-building works are: 3000 m³ of the soil and sand and 1500 m³ of snow were worked out at the object “Proving Ground”. Four test tracks have been built: 1 is the 400x30 straight acceleration snow one, 2 is the 1700x5 curved snow one, 3 is the 100x30 straight ice one and 4 is the 850x5 curve ice one.

The complex of the performed works allowed proceeding to the extreme tire tests already in the first winter season of 2019.

An annual work program includes two test cycles in the spring and autumn with duration of 2 weeks. During 2012-2018, 11 complex tests of automobile tires were carried out. The January trials of 2019 are the twelfth in a row.

Geographical location of the universal proving ground allows one to test the running trials of the automobile tires, machinery and transport equipment on the different types of the snow-covered and ice roadbeds under the natural conditions of low temperatures and also to support the introduction of the innovative technologies that will help to increase a level of safety on the roads.
4. Conclusion
The climatic features of the region, namely the terrible cold and endless winter are the key advantages of our proving ground to the rest. It is impossible to repeat the extremely low temperature and long winter in any of the existing auto proving grounds in the world.
In addition to the climate, the advantages of the Yakutsk proving ground certainly include the advantageous geographical location and logistics, which is important for Asian tire manufacturers; an attractive investment climate in the form of a favorable exchange rate of the national currency and the TPD’s preferences, which make it possible to conduct a flexible pricing client policy and reduce operational costs.

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