**Advanced Development and Testing of Off-Road Vehicle**

George Olegovich Kotiev\(^1\) and Alex Sergeevich Diakov\(^2\)

\(^1\)Russian Federation, Moscow, Perovscaya 66, k. 4, ap. 12  
\(^2\)Russian Federation, Balashiha, Dmitrieva 24, ap. 279

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**Abstract.** The article presents the definition of off-road vehicles and examines the main areas of its application. The classification of off-road vehicle according to the conditions of use and load capacity is given. The types and composition of support-running systems that determine the constructive appearance of off-road vehicle are considered. The key problems in the development of off-road vehicle are identified. A number of requirements have been formulated for the perspective designs of off-road vehicle. The main ways of creating competitive off-road vehicles in the Russian Federation are determined.

Off-road vehicles—ground vehicles for transportation of the passengers under the conditions of poor network and absence of the roads. Apply of off-road vehicle: transport accessibility of the population; the provision of goods and services (medical, energy, information, etc.); wildlife management (Ministry of Agriculture of the Russian Federation, Ministry of Natural Resources of the RF); elimination of emergency situations and rescue operations (Russian Emergency Situations Ministry); scientific research (the Russian Academy of Sciences, Ministry of Education and Science of the Russian Federation), industrial transportation (mining, exploration, etc.); State Security (the Russian Ministry of Defense, the Ministry of Internal Affairs) \([1-4]\).

Classification of off-road vehicle according to use conditions is shown in Fig.1

![Classification of off-road vehicle according to use conditions.](image)

Nowadays in the Russian Federation the next classification of off-road vehicle is accepted:
- Up to 0.5 t, the wheel (4х4, 6х6, 8х8), and a crawler-track ATVs ski (Fig. 2 a, b).
- Up to 1 m, wheeled vehicles on low pressure tires (4х4, 6х6) and tracked vehicles (Fig. 2 c, d);
- 2 - 3 m, wheeled vehicles on low pressure tires (4х4, 6х6, 8х8), tracked vehicles and articulated tracked vehicle (Fig. 2 e, f);
- 4 - 6 m, wheeled vehicles on low pressure tires (6х6, 8х8), tracked vehicles and articulated tracked vehicle (Fig. 2 w, s.);
- Up to 10 t, wheeled vehicles on low pressure tires (8х8) trains for low tire pressure, tracked vehicles and articulated tracked vehicle (Fig. 2 i, k);
- Up to 20 t, lorry tires at low pressure and articulated tracked vehicle;
- Up to 30 tons and above, road trains at low pressure tires and articulated tracked vehicle.

The most difficult climatic area for off-road vehicles is the Arctic zone of the Russian Federation.

The constructive shape of off-road vehicle depends on the type of support-suspension system, which may consist of propeller and the support (discharging) modules. In the off-road vehicle are widely used the following types of propulsion: the wheel (wheel-walking); crawler; navigable (propellers, water jets); rotary screw.

There are the next types of support modules used for off-road vehicle: ski-vehicle, hovercraft, tracked and wheeled.

The above made analysis of a number of conditions, under which it’s possible for off-road vehicle to work, gives an opportunity to put forward the following key problems in its development:
- Low temperature leads to a change in requirements for units, systems and operational materials (e.g., in the work of internal combustion engines, friction elements, rubber products, etc.);
- increased in the comparison with the usual conventional operating conditions the total resistance to movement leads to the fact that the internal combustion engine and transmission constantly operate in the zone of increased load, which is characterized by increased wearing of details and decreased durability;
- For movement on the support surfaces with a low bearing capacity necessary condition is to reduce the ground pressure. To overcome gullies, glades and other water obstacles by swimming, it is necessary to ensure off-road vehicles with amphibious qualities.
- To overcome a long distances between localities it is also necessary for off-road vehicle to have an autonomous character (up to 3 days), which in its turn implies an increase of power reserve (determined by propulsion’s efficiency, and efficiency of power transmission) and increasing of power supply. During prolonged autonomic actions one of the off-road vehicle’s defining characteristics is reliable character of all systems.
In this connection a number of requirements to off-road vehicle's prospective constructions is formed (Fig. 3).

The requirements to prospective constructions of off-road vehicle.

For the implementation of energy efficiency and improving of security a number of advanced design solutions for off-road vehicle are put forward. Part ICE, application of gasoline, diesel and liquefied gas engines. Regarding transmission, the use of automatic shift step boxes (hydromechanical transmission, manual transmission) with adaptive control laws, automatic stepless (electromechanical transmission; hydrostatic transmission) with adaptive control law and
the adaptive automatic stepless summing power to the thrusters. The propulsion part: for wheeled vehicles - the use of large tires for low and ultra-low pressure with an adaptive pressure control and safety inserts; for tracked vehicles—use RUBBER caterpillars; for machines with rotary-screw propellers (RVD)—the use of RVD with flexible membranes. As part of the support systems: the use of composite structures in order to reduce its own weight. There is also a need to provide off-road vehicle with life-support systems, including onboard accommodation modules for trucks and means of enhancing mobility and rescue operations.

Tests of off-road vehicles directed to determining of the acting functions and improvement of the structures (regional tests), as well as to confirming the respective characteristics and safety (certification test). There are special centers of experimental researches and testing of off-road vehicle in Russia, such as Federal State Unitary Enterprise «Central Scientific Research Automobile and Automotive Engines Institute», JSC «FIITS M», 3 CRI Defense Ministry.

Thus, we can identify the main ways to create a competitive off-road vehicles:
1. Economically justifiable use of commercially available wheeled and tracked vehicles and components for the creation of off-road vehicles with modifications for extreme operating conditions.
2. Creation of production of new components and structures using the scientific capacity (Federal State Unitary Enterprise «Central Scientific Research Automobile and Automotive Engines Institute», Moscow State Technical University named after N. Bauman, National State Technical University (NSTU) named after N.A. Alekseev, Research Institute of the Russian Ministry of Defense etc.).
3. Development of technical regulation in the sphere of off-road vehicle.

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Reference


