Ensuring the performance of equipment during the warranty period of operation

S Kushnarev
Bauman Moscow State Technical University, 5 Second Baumanskaya Street, Moscow, 105005, Russian Federation

E-mail: kushnarevl@mail.ru

Annotation. The problem of increasing the reliability of domestic technological machines and equipment remains relevant and requires a speedy solution in the current conditions of acute competition in the market of equipment and technologies. The low level of reliability of equipment reduces the efficiency of using machines and the quality of their technological processes, increases operating costs. The solution of this problem, as the results of research show, is impossible without participation in ensuring the operability of technological machines and equipment of manufacturers of modern domestic equipment. Providing engineering and technical support for manufactured machines, taking part in technical service, equipment manufacturers have the opportunity to study the reasons for the low reliability of units, units, connections and take measures to exclude their appearance. By setting the wear rate of the working surfaces of the critical interfaces in real-world operating conditions of the machine, it becomes possible to control its reliability and efficiency.

The purpose of the research
The purpose of the research is to increase the efficiency of using modern high-performance equipment by attracting the forces and resources of equipment manufacturers and technical service companies to ensure a high level of failure-free machines and study the causes of failures. The low level of reliability of domestic equipment requires increased expenditures of all types of production and technical resources in the operation of even new machines and equipment, leading to unproductive losses of working time and production. Consumers, when purchasing equipment, pay for quality manufactured machines, hoping that they will serve them properly not only during the warranty period of operation.

Introduction
One of the main reasons for the low quality of manufacturing and reliability indicators of modern machines and equipment of domestic production is the absence and failure to ensure in practice the direct participation of manufacturers in restoring their performance in the event of sudden failures not due to the fault of the operating party. The consumers of machinery and equipment today almost don't even pay attention to the presence in the contract of supply of equipment items on the guarantees of the manufacturers, trouble-free operation of the machine, about the promised terms of elimination of consequences of failures and losses associated with downtime of the machine due to technical reasons, etc., because they had never been carried out [1–3]. It just so happened from time immemorial.
(or rather since the 60-70-ies of the last century), the main executor of works on technical maintenance of machines and equipment in warranty and post-warranty periods of operation were and are themselves consumers of technology to the Department of the chief mechanic (OGM) and (or) engineering and technical services (its). Although the structure of the economy have created the most powerful in the world repair and service industries in the face of enterprise system type "Goskomteleradio", almost all of mashinno-technological production sectors to service and repair machines and equipment companies used a method of self-service.

The system of planned economy initially did not provide for the involvement of manufacturers of equipment to eliminate the consequences of failures and ensure the performance of machines and equipment, even during the warranty period of operation. A significant reduction in productivity and operational efficiency of modern high-performance and expensive machines and equipment indicated the urgent need and feasibility of implementing a proprietary method of technical service to improve the quality of manufacturing and reliability parameters of modern equipment. One of the most negative consequences of the low quality of domestic machinery is the low level of competitiveness of Russian-made machinery and equipment [4–7]. It is almost impossible to solve the problem of improving the quality of manufacturing and reliability indicators without involving manufacturers of equipment, machinery and equipment without proper organization of the complaint work and ensuring the required level of performance of machinery and equipment during the warranty period of operation [7–10].

Research result
Currently, in practice, the created machines and equipment are designed to perform certain technological processes of production of products, works and services without due consideration and requirements of the actual production conditions of enterprises of various natural and climatic zones of the country. This is indicated and emphasized by the data provided in the reports on the results of tests and observations of new samples of machinery and equipment: pilot testing, tests at MIS and specialized laboratories, real operating conditions, etc. As a result, it turns out that the machine is not ready or intended for use in real (complex) production conditions. Manufacturing plants and other structures involved in the creation of machines and equipment are not interested in improving the reliability of manufactured equipment, reducing the number of failures, downtime of machines and equipment for technical reasons, and losses of products and their quality in real conditions of enterprises, firms and holdings [11–13].

To eliminate such negative phenomena, it is necessary urgently, if not to introduce a full-scale branded technical service of machines and equipment of domestic production, then, at the first stage, at least to involve manufacturers in eliminating the consequences of sudden failures that occur in new machines during the warranty period of operation. The introduction of branded technical service provides for the development and use of mechanisms that stimulate the improvement of manufacturing quality and the level of reliability of machines and equipment.

In order to ensure a high level of reliability and operability of machines and equipment during the initial warranty period, it is necessary to approach the (seemingly simple) technological processes of technical service with high requirements and obligations. Since the basis of uptime for the entire service life of the machine are the timeliness, completeness and quality while planned preventive measures, it is expedient to provide for their execution under the control of the manufacturer, at least in the initial period of operation (Fig. 1).

Organizational and technological design of technical service processes should begin with the justification and selection of a rational option for the distribution of functions, processes and work among all participants in ensuring effective machine use — manufacturers, consumers of equipment and technical service enterprises.

Obviously, in the current conditions, the first step should be to create a full-fledged service for pre-sale and warranty maintenance and repair of equipment at the manufacturers of machinery and equipment. Production and technological parameters of the services of the chief mechanic or engineering services of enterprises — consumers of equipment should be determined based on
the actual flow of requirements for maintenance AND Troubleshooting that occur during the warranty period of operation. The number of complaints currently received from consumers does not reflect the actual needs and cannot be used to justify these services [13, 14].

![Fig. 1. Structure of labor costs in the operation of machinery (tractors)](image)

The interests of the manufacturer, in this case, can be represented directly by its employees, who go to the location of the failed machine, establish as part of a qualified Commission, the causes of failures, opportunities and ways to eliminate the consequences of failures, decide on the earliest restoration of the machine or equipment and ensure its implementation, prepare a report on the work done with proposals and measures to exclude the occurrence of such failures in the future at all stages of the life cycle of the machine and equipment.

The most direct and active participation in the organization of work to eliminate the consequences of failures should be taken by territorial, district and regional services of Gostekhnadzor. In addition, Gostekhnadzor services should be assigned the functions of quality control over the operation of new equipment, both production and technical. On the one hand — the services of "Gostekhnadzor" they act as a controlling state body that ensures the correct, safe and efficient operation of machinery and equipment in real production conditions of enterprises and firms. On the other hand, participating in the work to eliminate the consequences of failures, they monitor the manufacturer's compliance with their warranty obligations. Thus, they protect the rights of consumers of equipment and participate in the process of improving the quality of manufacturing and reliability parameters of machinery manufactured by machine builders.

**Proposed solution**

As a direct main executors of works on technical service can be used by own strength and means of the enterprises of consumers of technology — chief mechanic service or engineering service to manufacturers of goods, works and services, or be involved in the next maintenance enterprise, which is the official technical representatives of the manufacturer (Fig. 2). From the point of view of efficiency and cost — effectiveness, the first option is the most appropriate-by the forces and means of its own OGM or its. The possibility of using this option for organizing maintenance work requires the necessary repair and technical base, its technological equipment and personnel directly on the farm. Otherwise, it is advisable to perform technical service work in the company's technical center of the manufacturer of technical services [15, 16].
Fig. 2. Organization of maintenance and study of the causes of failures during the warranty period of equipment operation

After establishing the causes of sudden failure and its consequences, issued a report (complaint), signed by representatives of the manufacturer, the consumer operating the machine (equipment), maintenance enterprise and "STS". The main sections of the report are: characteristics of failure, reasons for failure, performers and ways to eliminate the consequences of failure, organization of work, recommendations to production (designers, designers, technologists) and (or) consumers to exclude such failures in the future. This report is immediately sent to the manufacturer (manufacturer) or to the main (head) company technical center, from where it is sent to all structures of the company, as well as to related companies and suppliers of components. The updated list of structures for mailing materials is determined by the manufacturer of equipment.

Management of the manufacturing company, together with the departments of advertising work, technological, technical control, planning and organization of technical service during the pre-sale and
warranty period of operation of new equipment, determines possible production reasons that caused the failure and develops measures to eliminate them. If this requires improving the design of products, their modes of operation, lubrication of the working surfaces of parts, etc., then designers and designers are involved. Efforts are made by all structures that ensure the quality of manufacturing and operational reliability of manufactured equipment. If necessary, changes and additions to the technological process of manufacturing parts and Assembly units are made as soon as possible. If necessary, structural materials are replaced, dimensional tolerances are tightened, working surfaces of critical parts are strengthened, etc. The working documentation may include additional requirements to strengthen control over the operation of certain components and units during the operation of the machine, and the spare parts kit may be supplemented with details to quickly eliminate the consequences of failures [14–20].

The need and feasibility of rapid and timely elimination of the consequences of failure are dictated by modern conditions not only market competition, but also a better consumer protection technology. In contracts for the supply of agricultural, construction and other equipment, manufacturers ’ obligations to ensure the quality of products and guarantees to eliminate the consequences of failures no later than a certain period of time gradually appear.

Innovative development of mechanical engineering, as the results of organizational and technological research show, is impossible without full ensuring the priority of consumer rights, primarily for high-quality equipment, and not its constant maintenance and repair. This requires the development and implementation of proprietary technical services and organizational and economic mechanisms to encourage improvement of the quality of engineering products. To improve the economic liability of equipment manufacturers have developed and are preparing to introduce the methodology for determining costs and detriment the consumer on occurrence of the failure and downtime of machines and equipment not his fault. And this, with the existing level of quality and reliability of modern domestic equipment, threatens machine-building enterprises, if not with bankruptcy, then with huge economic difficulties.

**Conclusion**

Thus, market competition, ensuring the priority of the rights of consumers of equipment, tightening economic responsibility for the production and supply of low-quality products require every possible improvement in the quality of domestic machinery and equipment. The only correct way to solve the problems of improving the quality of domestic equipment is to introduce a proprietary method of technical service. Only in corporate of technical service possible to organize at the proper level of technical service of machinery and equipment of domestic production in warranty period, what is the first step towards the creation of competitive engineering.

**References**

[1] Aleshin N.P. et al. Using nondestructive testing methods for in-production quality control of additive manufactured parts // Russian Journal of Nondestructive Testing. 2016. V. 52(9). P. 532–537. DOI: 10.1134/S1061830916090023

[2] Vasiliev A.S. Controlled Forming of Machine Components Operating Characteristics // Procedia Engineering. 2016. V. 150. P. 975–979.

[3] Nikolaev A.B. et al. Tools of production and logistics support life cycle of high-tech products // Life Science Journal 11 (10 SPEC. ISSUE). 2014. P. 238–242.

[4] Fedyukin V.K. Upravleniyekachestvomprotsessov [Process Quality Management]. St. Petersburg: Peter. 2005.

[5] Agostin V. Y. About the process approach in quality management // Standards and quality. 2010. Vol. 11. P. 36–38.

[6] Chernoivanov V. I., Severny A. E., Kushnarev L. I., and others. Problems of technical service in the agro-industrial complex of Russia (monograph). Moscow: GOSNITI, 2000. — 309p.
[7] Planned preventive MAINTENANCE and repair of machinery and equipment. Moscow: Mashinostroenie, 2001. — 369 p.

[8] Complex system of technical maintenance and repair of machines in agriculture. Part 1. — Moscow: GOSNITI, 1985. — 143 p.

[9] Technical operation of agricultural machines (with normative materials). — Moscow: GOSNITI, 1993.

[10] Cherepanov S. S. Maintenance and repair of machines in agriculture: (Fundamentals of scientific organization) / S. S. Cherepanov. — M.: Kolos, 1978. — 288 p.

[11] Strategic management of the company's organizational and economic stability: Logistics-oriented business design / A.D. Kanchaveli, A. A. Kolobov, I. N. Omelchenko, etc. Edited by A. A. Kolobov and I. N. Omelchenko. Moscow: Bauman Moscow state technical University, 2001, 600 p.

[12] Kushnarev L. I. Chepurina E. L., Kushnarev S. L. Problems and directions of development of engineering and technical support of rural commodity producers //Repair, restoration, modernization № 1. — 2016. — P. 3–9.

[13] Lipkovich E. I. Technical equipment of farms, organization of mechanized works and technical service of machines / E. I. Lipkovich, L. I. Kushnarev, L. M. Sergeeva // Engineering and technical support of the agro-industrial complex. — 1996. — N1. — P. 8–12.

[14] System of technical maintenance and repair of agricultural machines based on the results of diagnostics. — M.: Informagrotech, 1995. — 64 p.

[15] Chepurina E. L., Kushnarev L. I. Role and place of agricultural machinery manufacturers in corporate technical service //Machinery and equipment for the village. — 2013. — № 7. — P. 38–40.

[16] Kushnarev L. I., Didmanidze O. N. State and directions of innovative development of the engineering and technical service of the agro-industrial complex //International technical and economic journal, no. 1, 2014, Pp. 31–40.

[17] Kushnarev L. I. Chepurina E. L., Chepurin A.V., Kushnarev S. L. Quality and reliability of domestic equipment-the basis of its competitiveness //Tractors and agricultural machines. — 2015. — № 11. Pp. 35–37.

[18] Kushnarev L. I. [et al.]. Modernization of the technical service system of the agro-industrial complex. Scientific publication. Moscow: MESKH. — 2017.

[19] Chepurina E. L. Sevastyanova D. L. Improving the reliability of machinery and equipment in animal husbandry// Scientific and informational support of innovative development of the agro-industrial complex. Materials of the IX International scientific and practical conference "Informagro-2017". Moscow: "Rosinformagrotech". — 2017.

[20] Chepurina E. L. State of the organization of technical service of livestock machinery and equipment./International technical and economicjournal, no. 4, 2013. Spectrum LLC. —Pp. 61–67.