## CRITERIA FOR PROTECTIVE CONSTRUCTION MONITORING OF MAIN PIPELINES

***Alexander V. Komissarov***
Siberian State University of Geosystems and Technologies, 10, Plakhotnogo St., Novosibirsk, 630108, Russia, D. Sc., Associate Professor, Head of the Department of Photogrammetry and Remote Sensing, phone: (383)361-01-59, e-mail: a.v.komissarov@sgugit.ru

***Maria M. Shlyahova***
Siberian State University of Geosystems and Technologies, 10, Plakhotnogo St., Novosibirsk, 630108, Russia, Ph. D., Associate Professor, Department of Photogrammetry and Remote Sensing, phone: (383)361-01-59, e-mail: m.m.shlyakhova@sgugit.ru

***Maxim A. Altyntsev***
Siberian State University of Geosystems and Technologies, 10, Plakhotnogo St., Novosibirsk, 630108, Russia, Ph. D., Associate Professor, Department of Engineering Geodesy and Mine Survey-ing, phone: (383)343-29-55, e-mail: m.a.altincev@sgugit.ru

***Ekaterina N. Kulik***
Siberian State University of Geosystems and Technologies, 10, Plakhotnogo St., Novosibirsk, 630108, Russia, Ph. D., Associate Professor, Department of Photogrammetry and Remote Sensing, phone: (383)361-01-59, e-mail: e.n.kulik@sgugit.ru

The purpose of this article is to select and substantiate the criteria for protective construction monitoring of main pipelines. Main pipelines are constantly exposed to influences of external and internal factors. Special protective constructions are being raised to ensure the continuous operation of the pipelines. The main goal of creating protective constructions is to minimize economic losses and preserve the environmental characteristics of the facility. All existing protective constructions can be divided into two large groups: earth work and engineering constructions. Each of these groups includes different types of the constructions. All of them are designed to ensure safety of main pipelines from a certain natural phenomenon. It is also necessary to ensure constant monitoring of their geometric state regardless the protective construction type. Various data can be used for monitoring, among which the Earth remote sensing data perform a special role. One of the main issues in the construction monitoring is the explanation of the arising measurement errors. This requires knowledge of complex precision calculations theory. It is also necessary to take into account that a visual inspection of the construction defects is imperative in any calculations. A classification of protective constructions is given. The base of the accuracy calculation theory that is necessary to substantiate the errors in the protective construction monitoring is discussed. The main accuracy standards based on this theory are highlighted. The results of the performed analysis are the numerical values of the accuracy criteria for various protective construction types.

**Keywords:** main pipeline, remote sensing, accuracy standards, control, accuracy, active remote sensing, earth protective constructions, engineering protective constructions

### REFERENCES

1. Xrenov, N. N. (2009). Aerospace methods in a complex of studies to assess the technical condition of northern pipelines. *Izvestiya vuzov. Geodeziya i aerofotos"emka [Izvestiya Vuzov. Geodesy and Aerophotography]*, 3, 55–59 [in Russian].

2. Organization standard regulations on air patrolling of the main pipelines of OAO Gazprom. (n. d.). Retrieved from https://zinref.ru/000_uchebniki/01500_gaz/301_00_STO_gazprom_raznie/154.htm [in Russian].

3. Aerospace and aerovisual diagnostics of gas pipelines. (n. d.). Retrieved from http://gazdiagnoz.narod.ru/gaz09.html [in Russian].

4. Code of Practice. (2012). SP 58.13330.2012. Hydraulic structures. Basic Provisions. Retrieved from http://gostrf.com/normadata/1/4293793/4293793668.pdf [in Russian].

5. Standarts Russian Federation. (2004). GOST 31937-2011. Buildings and constructions. Rules for inspection and monitoring of technical condition. Retrieved from http://docs.cntd.ru/document/1200100941 [in Russian].

6. Code of Practice. (2016). SP 115.13330.2016. Geophysics dangerous natural influences. Retrieved from https://minstroyrf.gov.ru/docs/17066/ [in Russian].

7. Code of Practice. (2012). SP 116.13330.2012. Engineering protection of territories, buildings and structures from hazardous geological processes. Basic Provisions. Retrieved from https://minstroyrf.gov.ru/docs/1906/ [in Russian].

8. Code of Practice. (2018). SP 425.1325800.2018 Engineering protection of territories from erosion processes. Design rules. Retrieved from http://docs-api.cntd.ru/document/554403584 [in Russian].

9. Krez, V. G. (2019). *Sooruzhenie i ekspluatatsiya gazonefteprovodov i gazoneftekhranilishch [Construction and operation of gas and oil pipelines and gas and oil storage facilities: manual for graduate student]*. (2nd ed.). Tomsk: TPU Publ., 356 p. [in Russian].

10. Galiahmetova, A. V., Jadzinskaja, M. P., & Kaneva I. V. (2013). Assessment of natural and man-made factors for the purposes of engineering protection of pipelines in the permafrost zone. *Inzhenernye izyskaniya [Engineering Survey]*, 1, 52–55 [in Russian].

11. Babin, L. A., Grigorenko, P. N., & Jarygin, E. N. (1995). *Tipovye Raschety pri sooruzhenii truboprovodov [Typical calculations for the construction of pipelines]*. Moscow: Nedra Publ., 246 p. [in Russian].

12. Djatlov, V. A. (1984). *Obsluzhivanie i ekspluatatsiya lineynoy chasti magistral'nykh gazoprovodov [Maintenance and operation of the linear part of the main gas pipelines]*. Moscow: Nedra Publ., 246 p. [in Russian].

13. Vorobjov, Ju. L., Akimov, V. A., & Sokolov, Ju. I. (2005). *Preduprezhdenie i likvidatsiya avariynykh razlivov nefti i nefteproduktov [Prevention and response to accidental oil and oil product spills]*. Moscow: In-oktavo Publ., 368 p. [in Russian].

14. Xrenov, N. N. (2002). *Osnovy kompleksnoy diagnostiki severnykh truboprovodov. Aerokosmicheskie metody i obrabotka materialov s"emok [Fundamentals of comprehensive diagnostics of northern pipelines. Aerospace methods and processing of filming materials]*. Moscow: Gazoil Press, 352 p. [in Russian].

15. Askarov, R. M., Kitaev, S. V., & Islamov, I. M. (2019). On the technology of identifying pipeline sections with bending stresses when they intersect geodynamic zones. *Izvestiya Tomskogo politekhnicheskogo universiteta. Inzhiniring georesursov [Bulletin of the Tomsk Polytechnic University]*, 5, 18–25 [in Russian].

16. Hasenova, D. F. (2012). Possibilities of using aerospace monitoring methods for detecting leaks from oil and gas pipelines. In *Sbornik materialov I Mezhdunarodnoy nauchnoy konferentsii "Tekhnicheskie nauki: teoriya i praktika" [Proceedings of I International Scientific Conference "Technological Sciences: Science and Practice"]* (pp. 135–139). Chita: Molodoy uchenyy Publ. [in Russian].

17. Shilon, B. V. (1980). *Teplovaya aeros"emka pri izuchenii prirodnykh resursov [Thermal aerial photography in the study of natural resources]*. Leningrad: Gidrometeoizdat Publ., 247 p. [in Russian].

18. Bondur, V. G. (2012). *Aerokosmicheskiy monitoring ob"ektov neftegazovogo kompleksa [Aerospace monitoring of oil and gas facilities]*. Moscow: Nauchnyy mir Publ. Retrieved from http://www.aerocosmos.info/pdf/2012/2012_.pdf [in Russian].

19. Komarov, V. A., Semenova, Z. V., Bronnikov, D. A., & Nigrej, A. A. (2019). On the structure of the system of physical protection of trunk pipelines from deliberate threats. *Vestnik PNIPU. Geologiya. Neftegazovoe i gornoe delo [Perm Journal of Petroleum and Mining Engineering]*, *19*(1), 87–100 [in Russian].

20. Minkin, D. Ju., Terehin, S. N., Korolkov, A. P., & Osmanov, Sh. A. (2017). Space thermal imaging monitoring of oil and gas pipeline transport. *Pozharovzryvobezopasnost' [Fire and Explosion Safety]*, *26*(12), 45–51 [in Russian].

21. Zhukov, B. N. (2002). *Geodezicheskiy kontrol' sooruzheniy i oborudovaniya promyshlennykh predpriyatiy [Geodetic control of structures and equipment of industrial enterprises]*. Novosibirsk: SGGA Publ., 356 p. [in Russian].

22. Zharnikov, V. B., Djakov, B. N., Zhukov, B. N., & and etc. (1992). *Geodezicheskoe obespechenie ekspluatatsii promyshlennykh ob"ektov [Geodetic support for the operation of industrial facilities]*. Moscow: Nedra Publ., 160 p. [in Russian].

23. Zhukov, B. N. (1982). Accuracy standardization is the basis for improving the quality of engineering and geodetic works. *Trudy 7 s"ezda VAGO "Astronomicheskie i geodezicheskie issledovaniya" [Proceedings of the 7th Congress of VAGO "Astronomical and Geodetic Research"]* (pp. 76–79). Moscow [in Russian].

24. Zhukov, B. N. (1983). Standardization of the accuracy of geodetic measurements during the construction of structures, installation of equipment and monitoring their condition. *Izvestiya vuzov. Geodeziya i aerofotos"emka [Izvestiya Vuzov. Geodesy and Aerophotography]*, 4, 28–35 [in Russian].

Received 29.09.2020