RELIABILITY OF RUSSIAN PIPELINE SYSTEM

Management system

ELEMENTS OF THE MANAGEMENT SYSTEM	CORPORATE DOCUMENTS
OBJECTIVES	
The Company's policy related to improving the functional reliability of pipeline transport is governed by legal requirements and corporate standards	Federal Law No. 116-FZ "On the Industrial Safety of Hazardous Production Facilities" dated July 21, 1997, Federal rules and regulations on industrial safety "Safety rules in oil and gas industry" (approved by Rostekhnadzor order No. 534 dated December 15, 2020); "Rules for the Safe Operation of In-Field Pipelines" (approved by Rostekhnadzor order No. 515 dated November 30, 2017); other federal regulations and rules on industrial safety
PRIORITIES/STANDARDS	
Our priority is to adopt an integrated approach to the safe operation of pipelines: inhibitor coating, the introduction of corrosion-resistant pipes, timely diagnostics, and the prompt elimination of detected defects	Corporate regulations (STO LUKOIL 1.19.1-2012; 1.19.2-2013 and 1.19.3-2013)
INDICATORS	
The pipeline failure rate for oilfield pipelines, number of failures per 1 km, per year	Resolution of the Network Group "Improvements to the Oilfield Pipe and Tubing Reliability" of PJSC LUKOIL (further, Network Group)
ASSESSMENT	
The principal source of expertise is the activities of LUKOIL's Improvement of the Oilfield Pipe and Tubing Reliability Network Group, which forms part of the Corporate Knowledge Management System	Regulations on the Knowledge Management System of the Exploration and Production business segment (approved by the First Executive Vice President Ravil Maganov on March 19, 2014)
RESPONSIBILITY	
The system covers all management levels, from senior management to specialized units at LUKOIL Group entities. Responsible individuals in this area also include the experts and the head of the Network Group	The approved annual work plan of the Network Group as part of the Industrial Safety Program
TARGETED PROGRAMS, PROJECTS AND INITIATIVES	
Every Russian oil and gas producer has an investment program "The renovation and technical re-equipment of pipeline transport facilities"	Annual and mid-term investment programs of PJSC LUKOIL The Integrated Program on the Improvement of Oilfield Pipeline Reliability, adopted by each entity of the Exploration and Production business segment

Our goals

In Russia, LUKOIL operates a well-developed field pipeline system that is longer than the Earth circumference at the equator and the most extensive offshore pipeline system among Russian oil and gas companies (over 550 km, in length). We consistently carry out work to mitigate pipeline failure risks and have a well-run reliability management system for oilfield and mainline pipelines in place[1].

Our goal is the consistent maintenance and stabilization of the system and the reduction of pipeline accidents as per the best global practices.

Continuous and targeted work to improve pipeline reliability indicators is crucial for minimizing the risk of accidents. At the same time, other underlying causes, such as "human error" during construction, maintenance, and repair activities performed by service organizations, the integrity of other process equipment, etc., also influence the overall accident results. For this reason, we combine measures to improve the reliability of the pipeline system with steps to ensure the safety of production facilities and contractor responsibility.

Prevention of land spills

To improve pipeline reliability, we continuously monitor the condition of pipelines using various methods designed to prevent corrosion, as well as unintentional or intentional damage that may be caused by third parties.

The main activities under the "Reconstruction and technical re-equipment of pipeline transport facilities" program resulted in the following:

- Increase of the share of pipelines with anti-corrosion coating: when replacing corroded sections of pipelines, we used such pipes 100 percent of the time.
- Additional laying of internally coated pipes, which has increased on average 11 percent per year over the last five years.
- The share of pipes with a longer service life, as well as pipes made of non-corrosive materials, is being increased.
- The share of pipeline replacement in 2020 was 2.3 percent. The replacement volume and rate[2] are determined based on the results of diagnostics, examinations, and inspections of their technical condition and subject to the following criteria: any potentially hazardous sections and preconditions for incidents, scheduled increase in product transfer volumes, and elimination of regulations by regulatory authorities.

The share of operating pipelines, including corrosion-resistant pipes older than 20 years has been reduced. This indicator was 19 percent of the total length of the pipeline system in 2020 and decreased significantly over the past five years (it was 23 percent in 2016). The inspection and monitoring of these pipes are more frequent, with the concurrent use of several methods of control during one visit (for example, magnetic inspection, automated diagnostic complexes, and other modern methods).

Thanks to the comprehensive measures taken, reliability indicators improved in 2020 in the main oil production areas — Siberia and the Perm Territory. The specific coefficient of pipeline failures[3] in all Russian entities continued to decline in 2020 and stood at 0.062 cases per 1 km of pipeline per year (0.081 in 2019).

Reliability indicators of the Russian pipeline system, %

	2018	2019	2020
Share of corrosion-resistant pipelines	26.8	30.4	32.2

The principal methods of improving reliability of field pipeline operation

- Quality control of tubular products at manufacturing plants and close interaction with suppliers
- Industrial safety reviews, early engineering diagnostics, and corrosion monitoring of pipelines with a risk rating of anomalies and defects identified. Based on the results of inspections, identification of potentially hazardous sections that need to be repaired or replaced
- Expanding the application of alternative non-corrosive materials and pipes with internal protective coatings
- Application of inhibitor and electrochemical protection of pipelines

1. The information in this section pertains only to the Russian entities of LUKOIL Group.
2. The rate of replacing rejected pipes is determined not only by the Company's investment plans but also by the need to comply with statutory procedures and documentation.
3. A pipeline failure does not always entail a spill of oil, oil products or formation water, or a gas leak. Pipeline failure means a failure of performance associated with a sudden total or partial shutdown of the pipeline due to depressurization of the pipeline itself or shut-off and control valves or a blockage of the pipeline. The calculation uses the total length of pipelines (oil pipelines, gas pipelines, and water pipelines).

Pipes made of alternative materials. We see the use of pipes made of alternative (polymer) materials as the primary way to improve the corrosion-prone sections of pipelines. Non-metallic pipes are already in use at RITEK's facilities in the Volgograd Region, and field trials are ongoing at LUKOIL-West Siberia and LUKOIL-Perm's facilities.

The Ministry of Energy of the Russian Federation appointed an interdepartmental task force to develop national standards for the use of polymer pipe products. LUKOIL's experts partake in the work of the task force. In 2020, a national standard was developed for the design and operation of field pipelines made of fiberglass pipes, and this standard is expected to be approved in 2021, while two other standards for using polymer-reinforced pipes are to be developed and approved. We believe that with the new national standards in place and, given positive test results, the use of non-metallic pipes in the oil and gas industry will increase significantly.

Interaction with suppliers. Incoming quality control of pipe products delivered and cooperation with pipe manufacturers to improve the performance characteristics of pipes are vital aspects of our efforts to increase the reliability of pipelines.

The proposal by LUKOIL experts to use the manufacturer's pipe labeling will help in tracing products, including their reliability and quality indicators, and contribute to better reliability of pipelines in the Russian oil and gas industry overall.

In 2020, LUKOIL, together with a pipe manufacturer and with the participation of St. Petersburg Polytechnic University, conducted tests of various labeling methods, which resulted in determining the most promising types. Labeling durability and traceability of the pipe life cycle will be demonstrated by pilot trial runs scheduled for 2021–2022.

New methods for monitoring pipeline integrity

During the last two years, new methods to improve pipeline safety have been tested and implemented. These include:

- oil leak detection systems and technical devices that prevent hydraulic shocks;
- unmanned aerial vehicles (UAVs).

Leak and tamper detection systems, pressure stabilizers. Leak detection systems are being installed along vulnerable sections of pipelines to allow for early detection of even minor oil leaks and enable a response within 2 hours. The equipment has already been delivered to the Komi Republic and to RITEK facilities. Four of these systems have already been installed in the Komi Republic. We plan to continue expanding their use by installing seven more systems in the Komi Republic, the Perm Territory, RITEK facilities, and the multiphase pipeline at the new D-33V field in the Kaliningrad Region.

To ensure the safe operation of high-pressure water pipelines, self-pressure stabilizers that prevent fractures resulting from internal hydraulic shock are installed at potentially hazardous sections. This solution increases the reliability of high-pressure water pipeline operation.

Unmanned aerial vehicles. We started using UAVs (including those with internal combustion engines that can operate in Arctic conditions) for aerial surveillance of production facilities and monitoring of changes in conditions during emergencies. The main advantage of UAVs is the early detection of depressurized pipelines with oil spills. The frequency of flights depends on local conditions and the nature of the facilities: in particular, in-field and inter-field pipelines are circled at least once every three days.

LUKOIL's specialists have been working closely with contractors who perform aerial patrols using UAVs to fine-tune the software of the drones when operating in different weather conditions, as well as to improve methods of surveying and processing the data obtained.

Indicators

Since 2016, the indicators for the pipeline system reliability of Russian entities improved as a result of annual ISP activities. Yet, four significant[1] oil spills occurred in 2020 with oil released into water bodies (in the Komi Republic, the Nenets Autonomous Area, and in Western Siberia), which affected the data dynamics.

The detailed description of incidents can be found in Appendix 3, including preliminary data on the accident in the Komi Republic in 2021

LUKOIL's personnel acted strictly in accordance with the Spill Prevention and Response Plans with operational headquarters set up in all cases.
For localization and clean-up, the Company mobilized:

- 47 emergency response workers from the ERT, more than 19 pieces of equipment, and 4.5 tonnes of sorbent (on the Laia River in the Komi Republic);
- over 500 emergency response workers, more than 100 pieces of machinery and equipment, and over 27 tonnes of sorbent (on the Kolva River in the Nenets Autonomous Area);
- more than 20 emergency response workers from ERT, 12 pieces of equipment, and 1.5 tonnes of sorbent (on the Nong-Egan River in Western Siberia).

The root causes of accidents and lessons learned were analyzed by each of the Group entities and during the LUKOIL Safety Day. The root causes identified were:

- violation of labor regulations and work discipline by employees;
- use of unsafe work practices by contractors;
- improper handling of pipelines and their safe operation;
- failure of the production equipment.

Steps that were taken to efficiently respond to these emergencies were highlighted as "lessons learned".

- The use of UAVs made it possible to significantly cut the leak detection time and to accurately determine the contamination area and working conditions.
- The methodology for removing a spill in a fast-flowing river was finalized to include the following: the technology for installing oil booms was improved; the most suitable transportation (small vessels with outboard motors) and equipment (portable sprayers) were prioritized.
- The availability of trained personnel (including those with skills to operate non-standard equipment) facilitated the prompt cleanup of the spilled oil.
- Local residents were consistently kept informed, and the environmental community was engaged.

Indicators of oil spills in Russian LUKOIL Group entities

	2018	2019	2020
Volume of oil spilled in accidents, tonnes	32	16	43
Including significant spills, tonnes	0	0	6
Number of significant spills, incidents	0	0	4
Specific coefficient of spills, kg of spilled oil and oil products per 1,000 tonnes of extracted oil and gas condensate	0.4	0.2	0.6

Notes.
1. Data are provided for all the Russian oil and gas production entities under operational control (the list of LUKOIL Group entities can be found in Appendix 1).
2. The specific coefficient of spills is calculated based on the volume of oil and gas condensate production in Russia (excluding the share in affiliates).

1. The definition of a material spill is given in Appendix 6.