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Maintenance of the Romanian National Transportation System of Crude Oil and Natural Gas

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Abstract

In this paper we present a view on the organization of maintenance to the Romanian National Transportation System of crude oil and natural gas.
Currently, Romania has an important system of pipelines for transporting crude oil and petroleum products, built and equipped with up to date levels of technology, and a well developed network of gas pipelines, interconnected, forming the National Transportation System. Depending on the needs of mining, processing and consumption the transportation of fluid hydrocarbons continues to grow.
The primary means of transportation, for both liquid hydrocarbons and gas, it is thru the pipelines. Existing pipeline network in Romania continued to grow, reaching higher lengths, diameters and transport capacities. Thus the Romanian transportation system grew and now it integrates the activities of collection and preparation of oil and gas for transport and storage and those of distribution to consumers. In such a system, the central place it is occupied by the transportation activity with an array of specific issues that require careful consideration in order to find the best solutions both technically and economically.
The lack of a proper maintenance method used at a point where the crude oil pipelines overpass Prahova River in the village of Cartojani, after a heavy rainfall, has lead to damage to the pipeline supportive pillars, resulting in heavy repair costs.

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1. Maintenance systems

1.1. Introduction

Maintenance is defined as the process that contains all the operations thru which the equipment, the machinery and buildings are maintained to ensure optimum function [1].

Maintenance operations performed regularly reduce losses caused by failures and work related accidents.

In a crude oil transportation system, the main maintenance operations are mainly done in the pumping stations and implies the replacing of worn moving parts, completing the working fluid (lubricant, cooling liquid), adjusting the components and the removal of the wear factors (water, dust, acids, and so on).

The flow of maintenance activities is defined as a number of steps to be taken to perform a maintenance operation from the activities of preparation, such as education or policy clarifications, until the analysis done after actual maintenance activity and what actions are needed to be taken for increasing the quality level in future similar cases.

In order to achieve a high level of reliability and an optimum system availability process, there are three systems of maintenance, namely:

- preventive maintenance;
- predictive maintenance (current repairs, capital repairs);
- reactive maintenance.

1.1.1. Preventive maintenance

The same as the classic maintenance of transportation pipelines, which at regular intervals is tampered with in order to make repairs, regardless of its status, with a further classification into three categories:

- Systematic maintenance;
- Conditional maintenance;
- Preview maintenance.

1.1.2. Predictive Maintenance

It is defined as maintenance based on monitoring and diagnosis, by which defects are discovered and then according to this diagnosis the repair plans are established. This method was developed because the lifespan of the pipelines varies greatly according to external and internal factors that confront it. It prevents the pipeline replacement, which otherwise would imply great costs or the blockade of operations on that pipeline sector.

1.1.3. Reactive Maintenance

This method is defined as occurring on the pipeline on its failure, most expensive of the three types of maintenance and can be justified in case of the minor pipelines, where such operations are safe and no other system maintenance is justified.

It should be used a combination of methods based on a comprehensive risk analysis. The most effective maintenance program for pipelines, in terms of cost, will provide an optimal balance between the predictive and preventive maintenance to reduce the reactive one to the minimum possible (20%).

However, the literature of speciality shows that in the use of operation facilities where there are complex systems, in our case the crude oil pumping stations, a mixed maintenance should be used, covering both preventive and corrective maintenance operations.

This new system was imposed by the need to reduce the total costs for maintenance, but keeping an acceptable level of reliability for that facility.

1.2. Maintenance objectives

In the Romanian National Transportation System, maintenance has the following objectives[2,3]:

- The increase of productivity by reducing potential losses;
- Establishment of an autonomous system maintenance, provided by private operators;
- A system maintenance that will lead to the reduction of losses related to major equipment faults and more efficient use of equipment;
- Establishing a system of training for maintenance personnel;
- Establishing a system of monitoring and control of new products and equipment from the very beginning of their use;
- Implementation of Quality Control in Maintenance;
- Establish a more efficient collaboration between departments on issues related to maintenance;
- Compliance with laws and regulations relating to safety and the environment.

Evident, maintenance is no longer regarded as an activity that does not bring profit[4]. The time allotted for maintenance is considered as a part time work, and in some cases, as an integral part of the production process. The goal is to minimize and ensure a tendency to reduce to zero the output of machine function and unplanned maintenance interventions (see table no.1).

Complex systems require maintenance and service, an expanded team of specialists, as Egorova shows [5] to provide extended workforce required for periodic revisions or interventions to significant defects, in the remaining time the staff sometimes being below normal full time equivalent (FTE) [6].

It is recommended that the maintenance team to be put into a single decisional structure. Collaboration between professionals involved in different decision-making structures generates more difficulties in communication, in taking the decisions where rapid interventions are meant; also problems appear regarding the management of spare parts, tools and liability for defects due to maintenance staff.

The system will establish at regular intervals checks to ensure proper functioning of the installation, control, lock / off and alarm / signalling equipments.

Protection and control equipment, consisting of regulators, relief valves and other safety devices will be systematically checked and tested to determine if they are:

• in good mechanical condition;
• appropriately selected in terms of their capacity and safety in operation;
• set to operate at the proper pressure amounts;
• properly installed and adequately protected by other materials or conditions which may jeopardize the proper functioning.

Table 1. Maintenance objectives.

Indicator and measurement mode	Target Value Annual	Measurement Frequency	Tracking
Number of cases of pumping interruption due to technical faults reported in the previous period	< 10%	semester	monthly
For pumping due to interruption of technical failure cases reported in the previous period (shall be recorded when the damage occurred and when resumed pumping)	< 10%	semester	monthly
Optimization of fuel consumption	Fit fuel quota	monthly	monthly
Making interventions within	100%	semester	monthly

2. The physical status of the investment objectives / RK

After heavy rains Prahova river flow exceeded the normal rate, and flood eroded the soil under the supportive pillar of oil pipes Ø10 ¾ "Ø12" Ø14 "Cartojani-Ploiesti. (See figure 1). As an example, in this article, the state of physical investment objectives / RK refers to "Maintenance of securing pipelines crude Ø10 ¾" Ø12 "Ø14" Cartojani-Ploiesti in the Stejaru, Prahova river overpass "(see the table no.2).

Table 2. The physical status of the investment objectives / RK.

OBJECTIVE MAINTENANCE	MAINTENANCE INDUSTRY	Physical progress of the work
Works for securing oil pipelines Ø10 ¾ "Ø12" Ø14" Cartojani-Ploiesti in the Stejaru (Prahova river overpass)	PLOIESTI	***Works carried out:*** - Stripped aisle 6x170x1m; - Mattresses located (5x2x0, 5m) 130 pcs.; - Stone of the site; - Gabions (3x2x1m) R1=47 pieces (106m); R2=35 pieces (106m); R3=35 pieces (106m); ***TOTAL: 117 pieces / 318m*** - Used cement: R1=106m; R2=106m; R3=106m; ***TOTAL: 318m.*** *Note: R1, R2, R3 = rows*

2.2.2. Precautions during isolation station equipment for maintenance

Insulation, drainage and testing equipment shall be in accordance with the recommendations of the suppliers of equipment and in accordance with instructions [7].

a. Purging and leak

To be started safely, the equipment provided by pipeline leakage (e.g. pig launching stations, oil filters, centrifugal pumps, pipes) must be emptied and depressurized. Drained fluid is discharged to the specially designed leakage tanks to avoid environmental pollution and fire hazards.

b. Testing the pumping stations isolation valve in case of failure

Testing the isolation valve station in an emergency shall be in accordance with procedures issued by its manufacturer and will require stopping the pumping station.

c. Testing devices trigger

Triggering devices or in emergency operation (OSD / ESD) can be tested during periods of shutdown of the plant, or in normal operation by using the switches for the simulation of the functioning of the maintenance work. The switches are made in the normal operating position, after the test.

d. Insulation of electrical equipment

To prevent erroneous operation and accidents, isolation of electrical equipment shall be in accordance with the following rules [8]:

- "specific safety rules for the transport and distribution of electricity" approved by Order MMPS 275/17.06.02;
- "rules for electrical safety in the oil industry" (Order 78.1987 - MP);
- "general rules electrical installations maneuvers" PE118/92;
- "rules of prevention, fire fighting and equipment for the generation, transmission and distribution of electricity and heat" PE009/93.

Fig. 1. From top left are shown the works of securing oil pipelines Ø10 ¾ "Ø12" Ø14" Cartojani-Ploiesti.

3. Conclusion

Dependent on the needs of extraction, processing and consumption the Romanian crude oil transportation system continues to grow. The maintenance system used in the Romanian crude oil transportation system has to be improved, with focus on preventive and predictive maintenance. Due to an increasing risk of flooding, the places where crude oil pipelines overpass rivers are most exposed to damage [9] and should be the top priority for maintenance, therefore avoiding possible environmental disasters due to crude oil spilling into rivers and lowering the operating costs on the long term.

The next steps are to research and implement a solid management system, investigate other risk areas (e.g. pumping stations, pig launching stations), analyze the maintenance methods used and improve were it is needed.

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