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Stasiuk V.M.

*Candidate of Technical Sciences,
Associate Professor of the Department of Tourism and Civil Safety
Lutsk National Technical University*

SAFETY OF PRODUCTION PROCESS IN WATER SUPPLY AND SANITATION: AUTOMATION CONTRACTS AS A TOOL OF ITS IMPROVEMENT

БЕЗПЕКА ПРОЦЕСУ ВИРОБНИЦТВА ВОДОПОСТАЧАННЯ ТА КАНАЛІЗАЦІЇ: АВТОМАТИКА КОНТРАКТИ ЯК ІНСТРУМЕНТ ПОКРАЩЕННЯ ЙОГО

ANNOTATION

The article suggests the use of automation contracts as an effective economic tool that will provide improved safety and reliability of water supply and sanitation systems in Ukraine. The specific aspects that should be reflected in the significant terms and contract's annexes have been determined. The expediency of their primary concluding for automation of drinking water treatment technological processes has been substantiated.

Keywords: automation contracts, local automation, water supply systems.

АНОТАЦІЯ

У статті пропонується використання контрактів на автоматизацію як ефективного економічного інструменту, який дасть змогу забезпечити підвищення рівня безпеки та надійності функціонування систем водопровідно-каналізаційного господарства України. Визначено специфічні аспекти, які повинні містити істотні умови та додатки до зазначених контрактів. Обґрунтовано доцільність першочергового їх укладання для автоматизації технологічних процесів підготовки питної води.

Ключові слова: контракти на автоматизацію, локальна автоматизація, системи водопостачання.

АННОТАЦИЯ

В статье предлагается использование контрактов на автоматизацию как эффективного экономического инструмента, который позволит обеспечить повышение уровня безопасности и надежности функционирования систем водопроводно-канализационного хозяйства Украины. Определены специфические аспекты, которые должны быть отображены в условиях и приложениях к указанным контрактам. Обоснована целесообразность их первоочередного заключения для автоматизации технологических процессов подготовки питьевой воды.

Ключевые слова: контракты на автоматизацию, локальная автоматизация, системы водоснабжения.

Problem setting. The possibility of solving a vital task for the country – providing the population of Ukraine with drinking water in sufficient quantities and of good quality depends on the safety and reliability of water supply and sanitation systems (WSS). Of course, the safety and reliability level of these systems greatly depends on optimized modes performed in their operation. Besides, the «Guidelines for the development of optimization schemes of centralized water supply system and sanitation» [1, p. 3.8.2] states that perspective direction of these systems development is their automation, which makes it possible to achieve substantial increase in the water supply quality and reliability.

However, in the conditions of total decline of the WSS the task of automation of their production processes has only declarative character, as far as economic mechanisms of its realization

have not been developed at the state level, and in the conditions of lack of investment and absence of the state grants municipal water supply utilities are incapable of executing this task independently. Therefore, the search of effective economic mechanisms of the solving the task of the water supply systems automation acquires special scientific and practical significance, because the health level and life-span of Ukrainian nation will depend substantially on its successful decision.

Recent research and publications analysis.

A great deal of research made by the domestic and foreign scientists is devoted to the study of the WSS of Ukraine, the implementation of the advance experience of the developed European countries, the comprehensive analysis of various economic mechanisms of cooperation with specialized companies-contractors in the conditions of dilapidated economy and imperfections in national legislation (concerning public-private partnerships in particular) and others. Due to the limited size of the article there is no reason to enumerate all of them (the bibliography list contains only a small number of them).

Unresolved issues. All the above mentioned researches don't define any economic mechanisms and tools available for municipal water supply utilities that can be used for automation (total or local) of the water supply systems functioning.

The research objective is to suggest the use of automation contracts as economic tools for solving the problem of the municipal water supply system automation in Ukraine in order to improve its safety and reliability in the conditions of decline of WSS, the lack of its investment and the absence of the state grants.

Key research findings. Undoubtedly, in the conditions of political instability in Ukraine it is almost impossible to attract investors for carrying out capital investment in the water supply systems development (especially by means of their automation) due to the extremely high risk of investment default. However, the world practice shows, that the urgent tasks in the municipal sector can be solved not only by attracting large investment income and by concluding capital-intensive contracts with private companies and international financial institutions (concession, long-term leasing with investment obligations,

etc.), but it can be possible due to the short-term but clearly planned and mutually beneficial cooperation with specialized companies, enterprises and others. In particular, in the developing countries (nowadays Ukraine belongs to this group) the cooperation on the basis of service contracts has become widely spread in the water and wastewater sector [2, p. 20-21].

The essence of the above mentioned contracts lies in the concluding (according to the competitive principles) of the agreement between the utility and the private company with clearly defined legal obligations of the parties [3, p. 24; 4, p. 7; 5, p. 175]. In this case, the right for facility ownership and management functions performance remains in the municipality that bears all the risks of such cooperation [6, p. 390; 7, p. 3-4; 8, p. 81; 9, p. 46]. Bank loans can be included for implementation of relatively capital-intensive projects [10, p. 17], though, at the request of the contractor the latter can also take part in the investment project [4, p. 7]. The aim of such cooperation lies in the services reliability increase [4, p. 7; 11, p. 9], their prime costs reduction and the quality improving [3, p. 23-24].

Each party of the partnerships pursues their own interests in such cooperation. The municipal utilities benefit lies in the ability to borrow technical experience from the private partner and in the cost optimization [9, p. 46; 3, p. 24]. The service contracts are attractive for private companies from the point of view of the gradual eminence and authority acquisition ensuring a stable market in their future activities and (in some cases) privileges and preferences [6, p. 390; 12, p. 13; 13, p. 12]. The scientists offered different terms of such agreements concluding: 1-2 years [14, p. 9; 2, p. 21; 15; 16, p. 380]; 1-3 years [3, p. 23; 17, p. 12; 18, p. 20; 19, p. 169; 20, p. 9]; 2-3 years [11, p. 9; 4, p. 7]; 3-5 years [21, p. 170; 22, p. 98; 23, p. 83; 24, p. 217] and so on.

Having fulfilled comprehensive analysis of the specific characteristics of the service contracts in the above mentioned sources we can formulate the conclusion that they assure a local technical effect by means of successful decision of the determined tasks (which are very important for municipal water supply utilities). In particular this applies the cases when the enterprise doesn't have necessary practical experience and/or material resources for performing certain types of work (often of single-action or of non-specialized character).

The production processes automation at the municipal water supply and sanitation utilities is one of the types of these activities. Taking into consideration the fact that neither the state nor the municipal treasury are able to allocate the necessary funds for extensive water supply and sanitation automation, we find it appropriate to conclude the service contracts as widely as possible (in this case automation contracts) with specialized companies for performing the automation

tasks at the local level, such as the automation of individual structural components of the general water supply or sanitation systems.

Absolutely, the possibility of interaction of the separate automated systems at facility level and, in necessary cases, their transformation into a single automated system of water supply of higher (local) level, should be envisaged and technically provided in advance. The main functions of the total automated system will be:

- automatic technological processes management according to preset modes;
- automatic control of technological equipment modes;
- automatic technical state control of the water supply system's structural components;
- automatic technological parameters adjustment of the water supply system in order to achieve the standard indicators of drinking water quality and minimal power consumption.

Functional and structural analysis of the urban water supply and sanitation systems suggests that first of all the automation contracts at the local level should be concluded for:

- intakes surface and ground water structures;
- pumping stations and installations;
- water treatment plants;
- water pipes and water supply nets;
- storing water tanks.

Thus, in order to prevent possible misunderstanding in relations between partners, it is advisable to emphasize in significant terms of the automation contracts that the private contractor must strictly observe the agreement's annexes requirements, which should clearly establish both general and specific technical requirements of the water supply utility to its subordinate structure that is the automation subjects. For example, during the contracts concluding for the automation of a single pump station or installation, which are structural components of the water supply and water distribution system, the water supply utility should include the preventive requirement to ensure the interoperability of this structure with the other pumping stations of the total water system (especially local pumping stations), as well as with regulating tanks and regulation devices for conduits and networks. Moreover, the automatic system management as a whole should ensure the supply of the necessary daily volumes of water at the lowest total cost of capacity (under condition of simultaneous operation of all pump units), the value of free not lower than necessary network pressure, the lowest possible energy consumption per unit of water volume, preventing of individual units overloading, their work in low efficiency and cavitation modes.

At the coordination stage of the automation scheme developed by specialized companies the water supply utility should attract independent experts/group of experts for its evaluation and for implementation of its comprehensive analysis, particularly according to the index of the

expediency completeness to the prescribed order (functional usefulness level), reliability, saving of energy and so on. In order to avoid confusion with the contractor after the fulfillment of the project development and during the introduction of the automation system into operation the fact of the involvement of independent experts for evaluation of the automation scheme excellence should be reflected in significant terms of the automation contracts. This approach will secure the water supply utility from the private partner's unfair attitude to assigned commitments.

After the introduction of the automated system into operation it would be reasonable for the enterprise to conclude contracts for its planned preventive inspections, technical maintenance and repair work (or modernization works of the system) with the same private partner or another specialized company after expiration of the warranty operation period.

Concluding contracts for the water supply systems automation municipal utilities should pursue the objective of a significant reduction (or complete elimination) of the great amount of activities that are time-consuming, difficult and often dangerous for the employees life and health. Therefore, the performed complex analysis of many types of works, carried out on the water supply utilities, and the analysis of the specificity and principles of different technological equipment operation used for this purpose, allow us to affirm, that at the local automation scale the indicated contracts should be concluded primarily for:

- continuous water quality monitoring;
- automatic water level drop control on the grids and the surface water intake structures networks, and automatic water level measurement in the cells, ponds or watercourses;
- automatic water level and flow control in groundwater intakes structures wells and pressure control in the water lifting I pipe pump units;
- automatic pressure and water flow adjustment in order to reduce the energy intensity of the water supply processes;
- automation of support processes at pumping stations, including: rotating grids flushing, drainage water pumping, heating and ventilation, etc;
- automatic pressure and water flow measurement in pressure conduits;
- automation of water treatment plants technological processes including coagulants and other reagents dosing, chlorine, ozone and chlorine reagents disinfection, UV radiation, fluorination and disflourination by reagent methods;
- automation of preparing processes of contaminated filters and contact clarifiers for their flushing;
- automatic shut-off elements control on non-purified and purified water pipelines;
- automation of drum walls and micro-filters flushing process;

- automation of reagents dispensing process according to the quantity of hydrogen index pH and electrical conductivity;
- automation of reagents dispensing process for removing of carbonate hardness;
- automation of ion exchange filters regeneration: cationic – according to the residual water hardness, anionic – according to electrical conductivity of treated water;
- automatic control (at water treatment stations):
 - water consumption (non-purified, purified, flushing and re-used);
 - levels of water in filters, mixers, tanks of reagents and other containers;
 - sediment levels in ponds and clarifiers, levels of water flow and pressure loss;
 - residual chlorine or ozone value in the treated water;
 - pH index value of non-purified and purified water;
 - reagent solutions concentration;
 - other technological parameters requiring operational control;
 - automatic control of liquid chlorine depots chlorine pollution, chlorine measuring and other areas of water treatment plants;
 - automatic level control of undisturbed fire water volume, emergency volume level and the minimum water storage reservoirs level (necessary to ensure trouble-free operation of pumps mode).

The water treatment processes automation deserves special attention while concluding the indicated contracts, because their operation quality and excellence influences the population's health. Of course, such systems must be equipped with the latest control devices that will ensure the achievement of all the standard water quality indicators. In addition, in the case of water treatment plants technical upgrading or construction of new water purifying structures, in the annexes to automation contracts the water supply utilities must clearly specify their method of drinking water purifying and disinfection (with the obligatory prerequisite of automatic process control), the technical implementation of which should be made by the company-contractor. This should be oriented to the use of advanced technology, which effectiveness is confirmed by practical experience of developed European countries:

- UV disinfection of drinking water from surface sources;
- water disinfection with the compounds based on guanidine (easily accessible, have antibacterial properties, low-toxic, do not accumulate in the human body, corrosion inactive, allow to avoid chlorinated water completely or substantially reduce the number of reagents containing chlorine);
- drinking water disinfection with reagents which do not exert an oxidizing action (since the application of an oxidizing reagent action results

in significant contamination of drinking water by toxic chemicals – products of chlorination and oxidation with organic impurities);

- ultra-filtration – the latest membrane technology of drinking water purifying (advantages: the size of contaminants – 0.01 microns; complete removal of colloidal particles; higher safety level (compared to chlorination and ozonization) of disinfection process due to mechanical microorganisms removal and non-use of chemical reagents in the process filtering; natural mineral water structure conservation; possibility of filtration process correction by programming the controller for automatic flushing according to the index of non-purified and purified water quality, etc.).

The UV drinking water from surface sources disinfection (water supply for 70% of population of Ukraine) deserves special attention. The rivers are the common collector of waste water which is not always purified and disinfected to the proper level. UV disinfection avoids the use of chlorine and its derivatives, which entering the human body leads to poisoning, to cancer, unstable state of the cardiovascular and endocrine systems and so on.

Unlike chlorination, UV rays destroy not only bacteria but also viruses that can provoke dysentery, tuberculosis, hepatitis and others. UV installations are easy to operate, repair and maintain. They are characterized by a high level of security because technological process of water disinfection, used in these installations, does not use highly toxic substances, compared to water chlorination stations, which can have a negative impact on the health of service staff and lead to emergency situations in case of chlorine leakage. The use of automatic control systems in UV installation makes it possible to ensure their energy-saving independent mode operation without constant staff presence.

Conclusion. In the conditions of total decline of WSS systems in Ukraine the use of the automation contracts between the water supply utilities and the specialized agencies of regional, national and international levels is one of the few tools that are able to implement the tasks of automation of individual structural components of the total urban water supply systems in order to improve their safety and reliability. Therefore, the priority task is automation of drinking water treating technological processes since their quality and excellence finds its direct reflection in the health level and life-span of the Ukrainian population. In particular, in the case of construction of new water treatment plants or during their substantial technical upgrading the municipal water supply utilities should clearly specify in the annexes to automation contracts the chosen method of automatic drinking water purifying and disinfection, technical implementation of which should be made by the specialized company-contractor, giving preference to the most efficient of them, especially: UV disinfection (surface water sources), decontamination with compounds based on gua-

nidine; decontamination with reagents that do not create oxidizing action and ultra-filtration. In order to avoid confusion with the contractor after the fulfillment of project development and during the introduction of the automation system into operation the water supply utilities should attract independent expert/group of experts for objective evaluation of its activity, which should be reflected in significant terms of automation contracts.

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