Tyufanova A.A.

ANALYSIS OF FACTORS AFFECTING THE OPERATIONAL RELIABILITY OF VESSEL TRAFFIC SERVICE TECHNICAL FACILITIES

This article represents the analysis of factors affecting the functioning of Vessel Traffic Service (VTS) at the stage of intended operation. Failures of such structural elements as technical facilities – coast radar and radio relay stations – affect the quality of the whole system operation, as well as management decisions to be taken by a VTS operator. Therefore, it is concluded that the operation should ensure the most effective functioning of technical facilities.

Keywords: *system, operational reliability, technical facilities.*

Vessel Traffic Service (VTS) of the Russian Federation is an integral part of the State system of navigation safety. It is developed to be valid in seaport waters, internal waters, territorial sea and in adjoining zones of the Russian Federation. VTS systems are developed to enhance the maritime safety and navigation efficiency, safety of life at sea, protection of the marine environment and coastal area from possible contamination, protection of on-shore and off-shore facilities from damages in case of accidents at sea [1].

In accordance with the Provisions of vessel traffic service, the system is a redundant, recoverable, duplicated, constant long-lasting system with around-the-clock operation mode, consisting of several sub-systems: acquisition of information, remote control and data transmission, information processing and display, communication and data base – each subsystem is represented by technical facilities [2]. The system is functioning under the influence of external factors (environmental effects, emergency situations) and of intentional (controllable) process of recovery works, i.e. maintenance. That is why when speaking about the functioning we mean the complex of operational actions by VTS technical facilities, technical personnel operating TF, a VTS operator aimed at the common target.

Therefore, the operation shall ensure the most effective VTS functioning, i.e. the factor, reflecting the level of achievement of the aims and tasks assigned for the system during functioning. A set of the object's properties responsible for its operability to sustain certain needs in accordance with its designation is called the object's quality. VTS quality includes such features as safety, dependability, interference immunity, etc. Choice of the indicators of functioning quality depends on the tasks solved by the system, as these quantitative indicators determinate how well the assigned tasks are solved by the system [3]. VTS is characterized by many functioning periods, when the assigned task is being solved. These periods, when the system is fault-free and able to solve the assigned task without any errors, interchange with outage periods – these periods are forced, undesirable. They are caused by the failures and necessity of their elimination or prevention. That is why the more time in operable state is spent by the system and the less is the duration of forced outages, the higher is the VTS quality.

VTS quality indicators are:

- coefficient of technical use within a period (0, T), i.e. mathematical expectation of time fraction spent by the system in operable state during this particular time interval, or, in other words, probability to catch the system in operable state in random time. This coefficient does not depend on the state of the system at the moment when it starts functioning;
- availability factor, the probability of the object being in operable state at a random moment of time except the planned periods, during which there is no intended use of the object (preventive measures and maintenance);
- average profit per unit of calendar time;
- average costs per unit of time of the system successful functioning;
- characteristic of failure free operation – time to failure distribution.

Let us consider the process of VTS functioning in real conditions when the failures of its technical facilities are inevitable. All factors affecting the dependability of system during its intended operation can be nominally divided into the following categories: subjective (depending only on the activities of servicemen) and objective (related to the external influence on the facilities with internal processes, determining the ageing and deterioration of equipment). VTS includes technical facilities, software and a human operator (group of operators). VTS technical facilities perform their functions under the control of VTS operators and technical staff, which is why the system dependability during operation may deteriorate as the result of subjective factors (or so called human factor), significantly affecting the dependability of facilities at all stages of the life cycle.

According to the results of analysis of operational failure dynamics data, represented for the period from 2001 till 2013 in the form of maintenance registers for Novorossiysk port, we can classify the factors affecting operational dependability of technical facilities: weather conditions; energy factor; influence of spare parts on the VTS facilities operation. To define the factor of the most influence, as well as to define whether these factors are still relevant under the further VTS modernization, the expert estimation was performed [4]. The estimation showed that all the three factors are relevant regardless of the VTS modernization. The factors "energy factor" and "weather conditions" do equally affect the system operational dependability. The factor "spare parts influence" may or may not affect the system dependability – it depends on the particular conditions (proficiency of servicemen, downtime during maintenance, loss of a required spare part in the set, etc.).

The dependability is significantly affected by the deterioration and ageing which lead to degradation of technical characteristics and parameters [5]. Ageing of the elements results in different random hidden defects of materials, i.e. the insulation resistance decreases, and the values of certain resistance types grow, connector contacts oxidize, etc. The elements are getting aged not only during operation, but also during the process of storage – it is a continuous process of time affecting the facilities, the fastness of which is defined by both – external factors (weather conditions), and observance of all the service instructions by servicemen (timeliness and quality of preventive measures and maintenance, compliance with operation modes). The expert estimation of spare parts influence on VTS operation dependability showed that the dependability is influenced by the lack of expendable elements (magnetrons, etc.) within the scope of spare parts, as, due to their high cost, it is not possible to accumulate a required stock which results in the unavailability of spare parts; in the context of modern high-quality production the repair of broken facilities is often impossible or economically impractical outside large well-equipped specialized companies (service centers), having a great impact on the time required for the recovery of a failed component; basic national VTS standards [2], applied by the specialists, do not contain any fixed time terms for maintenance and preventive works.

The objective factors affecting VTS operational dependability include weather conditions and VTS power supply failures. The estimation detected 78 power supply failures. Failure means power supply quality defects. Most power supply failures were detected at the radar post "Gelendzhik" and at the observation post "Yuznaya Ozereevka", allocated in the end of a power supply line [6].

A power supply failure itself is not a significant hazard for VTS equipment, fitted with an uninterruptible power supply, but the high voltage (more than 340V), low voltage (less than 120V) and the voltage falls lead to the overloading of supply units of electronic devices, and therefore reducing their operating life; electrical noise causes the failures of program execution and data transmission, as well as unstable display representation on monitor screens and in video systems; harmonic voltage distortions lead to the disturbances in the operation of sensitive video monitoring systems; unstable frequency causes transformer heat problems, and besides, it tells about malfunction of the electric power system or its part.

The stage of operation of technical facilities plays a special part in VTS life cycle process, as all efforts spent on the development of a high quality system, can be nullified due to incorrect or impractical operation. Therefore, the operation shall ensure the most efficient functioning of technical facilities. Failures of such VTS structural elements as technical facilities – coast radar and radio relay stations have impact on the quality of operation of the system as a whole, and on the proper management decision taken by a VTS operator. On the basis of the fact that in real conditions CTS technical facilities perform functioning under the influence of external factors (weather conditions, changes of voltage in power supply system, etc.), as well as due to physical deterioration, the properties determining the quality of technical facilities and the efficiency of their functioning

may change. Improvement of the efficiency of operation of ports, fleet and environmental purity is known to be unimaginable without technical, methodical and organizational improvement of coast VTS. That is why the issue of VTS facilities dependability growth is currently quite relevant. This article describes the determining factors affecting operational dependability of technical facilities, which allows to define the main directions for improvement of the system operational dependability and the quality of its functioning.

References

1. "VTS Manual" IALA, 2004.

2. Vessel Traffic Service systems technical and operational requirements No. MF p2-22/848-70. M:2002.

3. **Tyufanova A.A.** Influence of maintained systems reliability on safety of navigation// North Caucasus Region. Technical sciences. – Rostov-on-Don: Platov South-Russian State Polytechnic University (NPI), 2008. – P.130-133.

4. **Tyufanova A.A.** Expert estimate of probability of a hazardous event under operation of complex technical VTS system of high responsibility// Coll. of research papers, issue 13. – Novorossiysk: "Admiral Ushakov State Maritime University", 2009. – P.137-140.

5. **Cherkesov A.N.** About the calculation of reliability of maintained systems with the limited amount of spare parts, with periodic replenishment. // Dependability and quality No.3. – Moscow: Publishing house "Technologies", 2003. – P.29-39.

6. **Tyufanova A.A.** Analysis of the effect of power supply quality on the operation of VTS equipment at the Novorossiysk port // Coll. of research papers, issue 13. – Novorossiysk: "Admiral Ushakov State Maritime University", 2008. – P.78-81.