Analysis and Optimization of Diagnostic Procedures for Aviation Radioelectronic Equipment

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EXECUTIVE SUMMARY

In this chapter, the authors present the questions of aviation radioelectronic equipment operation. The structure of operation system is considered based on processes approach with adaptable control principles usage. Operation system contains processes of diagnostics and health monitoring. The authors consider the direct problem of efficiency estimation for diagnostics process, and main attention is paid to probability density function calculation for diagnostics duration. Simulation results were used for adequacy testing of these calculations. The authors also take into account the possibility of first and second kind errors presence. The inverse problem for diagnostics is defined and solved for mathematical expectation of repair time. In general case, the inverse problem can be solved for seven options of optimization.

INTRODUCTION

In September 1991, at the Tenth air navigation conference, ICAO members endorsed the concept of CNS/ATM, which allows civil aviation to overcome the known shortcomings of the existing system on a global scale and take advantage of the latest technology to ensure the predicted development of aviation in the 21st century. In 1996, a «Global Air Navigation Plan for CNS/ATM Systems» (Doc 9750) was developed, which is a strategic document for guidance in the implementation of CNS/ATM systems.

To provide the safety and regularity of flights, CNS/ATM contains three segments: 1) ground-based radioelectronic equipment (REE) of communication, navigation, surveillance; 2) onboard avionics; 3) satellite equipment. The interaction between these three segments is carried out using data links, which include equipment, protocols, and data processing technologies.

There are three stages of the life cycle of radioelectronic equipment: design, manufacture, and operation. The longest stage is the operation. Scientific, design and operational organizations strive to minimize the costs of expendable resources from the beginning of REE design to its recycling. Operation systems for REE can also be considered as objects of design and optimization (Solomentsev, Melkumyan, Zaliskyi & Asanov, 2015).

According to functioning terminology, the operation is a stage of device lifecycle at which its quality is realized, maintained and restored. Operation contains: equipment usage, transporting, storage, maintenance and repair (Goncharenko, 2015). Maintenance is a part of operation and contains the same processes as operation does, except for the process of the equipment using for the particular purpose (Goncharenko, 2017).

BACKGROUND

According to reference (Dhillon, 2006), it can be presumed that the main components of the operation system (OS) are as follows:

1. Structural elements of the operation system and their structure.
2. Technological processes.
3. Executors (engineering personnel maintaining radio flight support facilities).
4. Operational facilities.
5. Administrative regulatory documentation.
6. Consumables.
7. Informational resources.
8. Operational conditions (climatic conditions, electromagnetic compatibility).

Practice shows that important technological processes (TP) for the operation of aviation REE are commissioning, flight and ground monitoring for equipment technical condition, material, and technical supply, recycling, the extension of equipment life, etc.

The process of intended use is the main process of operation. All other processes are designed to maintain the efficiency of the main process.

During the REE operation, the degradation processes can occur. This is due to the influence of the environment, instability of power sources, electromagnetic compatibility, etc. As a result, there are changes in the trend of the diagnostic parameters towards the maximum permissible (pre-failure) levels. Therefore, the purpose of operation system is estimation of the current and future technical condition of REE, on the basis of which it is possible to generate and implement corrective and preventive actions (Solomentsev, Zaliskyi & Zuiev, 2013; Solomentsev, Zaliskyi, Nemyrovets & Asanov, 2015; Solomentsev, Zaliskyi, Kozhokhina & Herasymenko, 2017; Goncharenko, 2018).