

Preface

This book on reliability deals with fundamental issues of modern reliability theory and practice. The continuous increase in speed, load capacity, productivity, accuracy, and energy intensity of machinery in the twentieth century, the development of air, space, ocean floor, and coastal shelf, and the concentration of numerous manufacturing equipment and vehicles on small territories have complicated the operation of machinery, increased the danger of man-made environmental disasters and loss of life. The volume of losses due to man-made disasters has become equal to the gross domestic product of some countries. This has demanded more and more attention to improve the reliability of machinery and contributed to the rapid development of reliability theory in recent decades. In the future, machinery reliability will become even more important, both because of the need for high productivity and technogenic safety (increased reliability, availability, and survivability), and because of the need to conserve natural resources and preserve the environment on the earth, in the air and space, and in the oceans and seas.

The main directions of development of the theory and practice of reliability assurance are creation of mathematical and physical models of reliability and approaches to their use in design, manufacture, operation, and storage of a database of emergency situations; the occurrence of defects, failures, malfunctions and emergencies, their diagnostics at all stages of the life of machinery; rationing of reliability indicators; forecasting the reliability and life span of machinery; development of methods and means of technical diagnostics; optimization and implementation of certification of the main components of the machinery.

These directions of reliability assurance are reflected in the following chapters of this book.

Chapter 1 describes the basic concepts of reliability theory and reliability indices. The peculiarities of reliability determination for different operating conditions and the main mathematical dependencies are also described in this chapter.

Chapter 2 describes the mathematical foundations of reliability theory, such as random events and their properties, characteristics of random events, and different types of distributions for random events.

Chapter 3 discusses the peculiarities of reliability analysis for non-repairable and repairable systems, the peculiarities of reliability function generation based on the structural method, and also the peculiarities of redundancy and reliability estimation for redundant systems. Parametric and nonparametric methods of analysis of such systems are described.

Chapter 4 is devoted to the methods of reliability analysis of complex systems. A brief description of the Failure Mode, Effect, and Criticality Analysis method is provided. A summary of FMECA and its applications is described. Information on fault tree analysis is provided. Basic concepts and qualitative and quantitative analysis approaches based on FTA are given.

Chapter 5 deals with model-based reliability assessment. An aircraft system was used as an example to illustrate approaches to system reliability assessment. Multiphase mission reliability analysis is also explained.

In Chap. 6, some aspects of reliability assignment and prediction were considered. Using an aircraft structure, system configurations, and redundancy features were considered. Reliability assignment was briefly explained with some real examples.

Chapter 7 discusses reliability analysis for mechanical systems. The main causes that affect the reliability of mechanical systems are described and briefly analyzed. A special feature of this chapter is an example of how to compute the reliability of the aircraft fuel system based on the theory described above.

Chapter 8 provides information on performing reliability testing. It describes procedures for performing such tests, some types of tests, and procedures for verifying the reliability test results.

Chapter 9 discusses probabilistic risk analysis of aircraft systems. It explains the background and examples of research on probabilistic risk assessment of aircraft engine life-limited parts. It also explains the theory and examples of risk warning technology to improve the reliability of commercial aircraft bleed air systems.

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