Preface

When new models of production articles are created, the basic knowledge about these objects comes from testing their prototypes. Such knowledge is obtained by measuring the parameters and characteristics of mechanical, thermophysical, gas dynamic, chemical and others processes that take place in such a prototype.

Progress in the creation of new knowledge as well as in the development of new technical and technological solutions largely depends on the accuracy of measurement results. Therefore, increasing the information content of tests and the reliability of their results are critical issues related to the development, manufacturing and overhaul tests of production objects. An effective solution to these issues, as practice has shown, is provided by the automated measurement-information systems (*AMISs*) with abilities to control the test object as well as the testing equipment. The *AMIS* allows to:

- receive a large amount of detailed measurement data;
- exclude the influence of human factors on the measurement results;
- ensure the required accuracy of test results.

The metrological characteristics of measurement means (*MMs*) produced by a particular manufacturer are generally well known. In the documentation that accompanies the *MM* there is always information about the measurement errors. This information can be common to the entire production series of the *MM* or it could be specific to a particular sample obtained via calibration on reference equipment. However, even for the *MM* with individual calibration, the measurement error may include components that require verification under specific working conditions.

As a rule, *AMISs* are created from products of various manufacturers according to technical requirements (*TRs*) including the requirements for measurement accuracy. The adequacy of system's metrological characteristics to the *TRs* is confirmed by a set of metrological studies and procedures for estimation of components of the error arising from individual components of the measurement channel (*MC*) as well as for the entire *MC*. In addition, some object parameters can be determined only through indirect or aggregate measurements, that is, by processing direct measurements of several physical values. In this case, it is necessary to carry out appropriate experimental and computational studies to determine the errors of such measurements. When the test object is in a non-stationary operational mode, it is also necessary to investigate the inertial characteristics of the *MCs*.

The monograph of Dr. Karmalita is devoted to the issues related to the accuracy of measurement results obtained using *AMIS*. It summarizes the author's vast and versatile experience in the field of *AMIS* design and the study of their metrology. After graduating in 1971, Viacheslav Karmalita began his career at the Central Institute of Aviation Motors (*CIAM*) as an experimental engineer for an altitude test facility. During the last decade (1983–1993) of his work at *CIAM*, he headed the

department for “Automation of Testing Aircraft Engines and their Components”. In addition to scientific research, Dr. Karmalita was engaged in academic activities as a post-graduate lecturer for “Statistical Methods for Processing Experimental Data” course at *CIAM*. Two students under his leadership went on to obtain *Ph.D.* degrees. Viacheslav Karmalita also published several monographs in English and Russian. Currently, he is a well-known expert in the field of *AMISs* with a specialty in the measurements of stationary and dynamic processes as well as statistical analysis of their results.

Since the measurement results are always probabilistic due to the presence of random components, the first chapter of this book is devoted to the issues of mathematical statistics. It gives a concept of probabilistic models and considers the elements of statistical estimation related to the adaptation of those models to experimental data.

As the given methods and approaches are accompanied by specific examples from the practice of testing gas turbine engines (*GTEs*), the second chapter provides a general idea about the *GTE*, the structures of the *MC* and *AMIS*, and the procedures for acquisition and processing of measurement results.

The third chapter describes the procedures for estimating metrological characteristics of the *MCs* for measuring stationary parameters. An approach to evaluate the accuracy of test results is considered as a logical prolongation of *MC*’s statistical tests and it is shown how to ensure the required accuracy as well.

The last chapter provides information about deterministic and random processes in a dynamic system that is the *MC*. It shows, how through dynamic calibration of the *MC*, the channel inertia may be presented in a formal description. Finally, a method for eliminating the systematic errors of transient process measurements is discussed.

This book is of interest to specialists involved in testing complex manufactured objects and is useful for graduate and post-graduate students with engineering specialties.

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Dr. Boris Mineev
Chief Metrologist of *CIAM*
Moscow, Russia