Classification Of Tests And Testing Equipment

Elleanora Narimanovna Yusupkhodzhaeva[1]
[1] Tashkent State Technical University 2, Universit Street, Tashkent, Uzbekistan, +998 91 162 62 33

Nargiza Utkurovna Batirova[1]
[1] Tashkent State Technical University 2, Universit Street, Tashkent, Uzbekistan, +998 91 162 62 33

Shokhodat Ruzimukhamedova[2]
[2] Institute of Labor Market Research, Tashkent

ABSTRACT

The article presents their classifications as the main information provided on the condition of the product based on the test results. When determining the classification, the quality of the choice of the program, methods and testing tools is taken into account, that is, the quality of the project, ideology, tests and related technical solutions, as well as the quality of the implementation of the chosen testing methodology, that is, the quality of the implementation of programs and methods.

Keywords: test, technique, program, degree, instruments, process, electromagnetic, mechanical, methodology, evaluation.

The main result of any testing is the information about the state of the tested object, i.e., the product. Therefore, the quality of testing is the quality of the information contained in its results, and the evaluation of the quality of testing is the assessment of this information.

The quality of the information obtained from testing is, in turn, determined by the quality of the choice of the test program, methods, and means, i.e., the quality of the design, ideology, and methodology of the tests, as well as the quality of the implementation of the chosen testing methodology, i.e., the quality of the implementation of the programs and methods.

In practice, the most common situation is when tests are conducted according to given programs and methods. In cases where these programs and methods are standard, their correctness is not questioned, and the evaluation of the quality of the tests boils down to evaluating the quality of the implementation of these documents.

The quality of the implementation of programs and methods can be evaluated both indirectly and directly [1].

Indirect evaluation refers to assessing the compliance with all organizational and technical requirements specified in documents regulating the conduct of tests: standards, programs, methods. For example, one can evaluate the correctness of reproducing test conditions, the choice of measuring instruments, etc. The more meticulously these requirements are met and the less the actual values of the test conditions deviate from the set ones, the more accurate the tests are [2].

In this case, the evaluation of the quality of testing consists of evaluating the state of the technical means, the organization of the tests, and the quality of the work of the personnel conducting the tests.

It is especially important to note that the technical level and the quality of the products reflect the level of the enterprise, the country's economy, and characterize the standard of living of a person and society as a whole.

The technical level and quality of products are evaluated by a set of indicators determined by the results of testing. Therefore, testing plays an important role at all stages of a product's lifecycle. It allows for verifying the correctness of selected design and technical solutions, assessing the degree of compliance of product quality indicators with standards and technical specifications, and preventing the release of substandard products.

Testing serves as an objective assessment of the technical level and the quality of product manufacturing, helping to make decisions about launching new products into production, ending serial production, continuing mass production, the feasibility of imports, and confirming compliance.

An objective assessment of the technical level and quality of a product implies obtaining reliable information about the actual values of quality indicators throughout its lifecycle. This means that testing includes both evaluating the characteristics of the product during development or preparation for production, as well as controlling these characteristics during its operation. In this context, the term "testing" refers to a technical operation aimed at determining one or more characteristics of the product, process, or service according to a defined procedure [1].

Testing is a complex cognitive process of obtaining information about the characteristics of an object through measurements, analysis, diagnostics, expertise, etc. The most common method of obtaining information about the properties of an object is measurement, which allows for determining the value of a parameter with a certain degree of accuracy. Unfortunately, not all characteristics of objects can be measured using measuring instruments; sometimes other means, such as sensory evaluation, are used to give a qualitative assessment of the object's properties.

Evaluating the properties of an object is performed when the actual values of the characteristics are needed; controlling characteristics is done when the task of the test is to establish compliance with the set requirements.

A distinctive feature of testing is the establishment of specific conditions, both real and simulated. These conditions can include climatic, mechanical, electrical, thermal, radiation, chemical, and other factors. The operating modes of the object and the values of its operating parameters during testing are also defined. Testing conditions may specify particular characteristics of the object during its operation or inoperative state, before or after the application of these factors. These conditions are set and maintained with a certain degree of accuracy. Testing conditions are defined and ensured in the test methodology [5].

A key concept is the definition of the term "object of testing." It is essential to distinguish between the object of testing and the test sample, which represents a unit of the product or its part. The sample is the object of experimentation during testing. The results of testing the samples are used to make judgments about the product as a whole.

The main features of any test are:

- The adoption of decisions based on the results, such as determining the product's suitability or rejection, whether it can be presented for further testing, etc.
- The definition of required real or simulated test conditions.

Test conditions refer to a set of influencing factors and the modes of operation of the object during testing. The relevant documents for specific objects must define the standard test conditions.

The goal of testing is to determine the true value of a parameter or characteristic under specified nominal test conditions, not the real conditions that the object may actually experience during testing. Real test conditions almost always differ from nominal ones because it is impossible to determine the exact parameters of the test conditions. Therefore,

the result of a test always includes some degree of error, caused not only by inaccuracies in determining the sought-after characteristic but also by the imprecision in setting the nominal test conditions.

The result of the testing is the evaluation of the object's properties, establishing its compliance with the set requirements based on the test data, and analyzing the quality of the object's performance during the tests. The accuracy of testing refers to the property that shows how close the results are to the true values of the object's characteristics under certain test conditions.

There is a significant similarity between measurement and testing:

- The results of both operations are expressed in numbers.
- The errors of both operations can be expressed as the difference between the measurement result and the true value of the measured quantity.

However, from the perspective of metrology, there is a significant difference between them: the measurement error is only one component of the overall testing error. Therefore, testing can be considered a more general operation than measurement. Measurement can be seen as a specific case of testing, where the test conditions are not important [2].

Control refers to the process of verifying the conformity of a product's parameter value to established standards. The essence of any control consists of two main stages. The first stage involves obtaining information about the actual state of the object and its property indicators. This information is called primary data. The second stage involves comparing the primary information with pre-established requirements, standards, or criteria. Conformities or discrepancies between the actual data and the required values are identified. The information about the discrepancy is called secondary information. Secondary information is used to make decisions about the object being controlled. In some cases, the boundary between the stages of control is indistinct, and the first stage may be vaguely expressed or practically unnoticeable. A typical example is the control of the size of a part using a caliper, which boils down to comparing the actual and maximum permissible parameter values.

Control consists of several elementary operations:

- Measurement conversion of the controlled quantity.
- Reproduction of control settings.
- Comparison and obtaining control results.

Measurement and control are closely related, similar in their informational essence, and contain many common operations. However, the measurement and control procedures differ significantly:

- The result of measurement is a quantitative characteristic, while control results in a qualitative one.
- Measurement occurs over a wide range of values of the measured quantity, while control is usually limited to a narrow range of possible states.
- Control instruments, unlike measuring instruments, are used to verify the state of products whose parameters are given and change within narrow limits.
- The main characteristic of measurement quality is accuracy, while the main characteristic of control procedures is reliability.

A widely used form of control is acceptance control, which involves determining the value of the controlled parameter by measurement or testing and comparing it with the specified limit values. A special case of acceptance control is calibration, which examines whether the measurement instrument's errors fall within acceptable limits.

The development of new types of products, continuous improvements in quality standards, the increasing complexity of technology, and the variety of product operating conditions have led to the variety of

tests conducted at different stages of a product's lifecycle.

The main tasks of these types of tests are:

- Acceptance testing: determining compliance with the technical specification, standards, and technical conditions, assessing the technical level, and determining the possibility of production. Conducted when introducing new products into production.
- Qualification testing: determining the readiness of production for serial manufacturing based on a well-established production process that ensures stable quality and necessary quantities. Testing is done on products from the initial or first batch and is performed when deciding on the end of the pilot production phase and the start of serial production.
- Acceptance-delivery testing: testing the product during acceptance control. Conducted by the manufacturer or the customer.
- Periodic testing: testing of the produced goods conducted in volumes and within the periods specified by regulatory documentation to control the stability of product quality and the possibility of continuing its production.
- Inspection testing: checking the stability of quality, reliability, safety, and other operational characteristics of the product. Conducted on the request of the Federal Agency for Technical Regulation and Metrology and other federal bodies, as well as by order of controlling or investigative bodies to decide on the continuation of serial production.
- Certification testing: establishing compliance with international or national standards. Conducted when deciding on the feasibility of imports and the issuance of a certificate of conformity. Certification testing is performed in recognized testing laboratories authorized to conduct certification testing.
- Stand testing: testing conducted on testing equipment.
- Mechanical testing: tests on the impact of mechanical factors.
- Climatic testing: tests on the impact of climatic factors [3].

All types of tests involving external factors are conducted to check the operability and appearance of the product under or after exposure to these factors. Depending on the purpose of the testing, external factors tests can be classified into tests for strength and tests for durability:

- Strength testing: tests conducted to determine the values of influencing factors that cause the object's characteristics to exceed the set limits or result in its destruction.
- Durability testing: tests conducted to control the ability of the product to perform its functions and maintain parameter values within the established norms during the action of certain factors.

The methods of conducting these tests are not significantly different. The main difference between strength and durability tests lies primarily in the duration and the fact that they are conducted on products not intended for use under these influences, but only subjected to them during transport. Therefore, strength tests are performed on non-operating products, and the parameters of these products are measured before and after exposure. The second main difference is the level of influence, which is much higher in strength testing.

There are three main ways to conduct laboratory tests: sequential, parallel, and combined.

Sequential testing involves applying different external factors to the test items one after another and observing their condition. A key condition for sequential testing is the order in which external factors are applied. It is recommended to start testing with the least severe factors that carry the least risk of failure. The sequence of tests depends on the

product's purpose and the expected operating conditions. Therefore, for each product, the sequence is different. It is recommended to begin with electrical and mechanical testing. A disadvantage of this method is that the results depend solely on the impact of one factor, which makes it difficult to draw conclusions about the product's behavior under real operating conditions. Furthermore, this method is time-consuming and results in significant wear on the product.

The parallel testing method involves subjecting several products to various factors simultaneously, significantly reducing testing time.

Combined testing involves applying several factors to the product simultaneously. It allows for determining how the product responds to the simultaneous effect of several external factors, thus better approximating real operating conditions. The advantages of this method include reduced testing time and the ability to identify failures that might not be detected under sequential or parallel testing. However, it complicates the determination of the cause of the failure and significantly complicates the equipment needed.

It is important to note that combined testing does not always lead to more stringent test conditions. Combined testing can also result in coating damage. These damages accelerate due to the alternate expansion and contraction caused by temperature changes and the variable bending caused by vibration. Cracks form in the coatings, allowing moisture to penetrate components, which can change the capacitance and resistance values of components on printed circuit boards, leading to the complete or partial failure of electronic components.

Functional testing is also distinguished as testing conducted to determine the purpose-related indicators of the object.

All influencing factors are classified as:

- Climatic: temperature, humidity, atmospheric pressure, solar radiation, airborne impurities, biological factors, insects, rodents.
- Mechanical: vibration, shock, linear acceleration, acoustic fields.
- Electromagnetic: electric voltage, electromagnetic fields, magnetic fields.
- Chemical.

The technical base of testing consists of testing means, which are any technical devices, materials, or substances necessary for conducting tests. Testing means include reproduction devices, measuring instruments, fixtures, materials, and substances, i.e., everything necessary to perform testing [4].

An important category of testing means is testing equipment, which refers to devices that reproduce test conditions — influences on the object being tested and its operating modes. These include special stands, test machines, installations, climate chambers, and other devices that recreate the required test conditions: temperature, humidity, pressure, electromagnetic or radiation influences, acoustic impacts, and mechanical loads.

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