The principles of dependability terminology standardization

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Abstract. *Aim. The paper continues a series of publications discussing the dependability terminology and its standardization. It aims not to review and discuss specific terms, but rather to formulate the main principles that should be used as the basis for the development of a general terminology standard for dependability in technics. Such consistent general principles will enable easier solutions regarding specific terms and definitions.* **Methods.** *The general principles and requirements set out in the regulatory documents on standardization are specified in the context of the dependability terminology standard. The provisions of a number of other general technical standards that have an impact on the standardization of dependability terminology are also taken into account. Current and former terminology standards are considered, both domestic (GOST 13377–67, GOST 13377–75, GOST 27.002–83, GOST 27.002–89, GOST R 27.002–2009 and GOST 27.002–2015) and international (IEC 60050-191:1990 and IEC 60050-192:2015). The author analyzed to what extent they comply with the general principles; the shortcomings of the reviewed standards are identified.* **Findings and conclusions.** *The main principles that a general dependability terminology standard should conform to are formulated: continuity in relation to previous similar domestic standards, alignment with the international IEC standard, consistency with other general technical standards, internal consistency and logical coherence, generality and universality to meet the needs of all industries.*

Keywords: *dependability, terminology, national and international standards, continuity, consistency and coherence, generality and universality.*

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Introduction

Over the last years the standardization of dependability, in particular the terminology it uses, has been dwelt upon by various publications (e.g. [1–6], some more papers to be referenced further on). On the one hand, such an interest in the topic is good news for the author who has been working in this area for many years and has participated in the development of the interstate and international terminology standards. On the other hand, however, this is indicative of problems in the area [5]. It is also upsetting that discussions sometimes go around in circles and it seems as if discussants do not read carefully what has been written on the subject before or even are not familiar at all with the key provisions in the area of standardization established by normative documents.

This situation initiated the writing of this paper whose major aim is not to review and discuss specific terms, but rather to formulate the overall principles that should be used as the basis for the development of a general terminology standard for dependability in technics. The author hopes that if the general principles are agreed upon first, then it will be easier to come to solutions for specific terms and definitions.

Naturally, any standard shall comply with the requirements specified in the Federal law "On standardization in the Russian Federation" (dated 29.06.2015 № 162-FZ), in the standards of complexes "Interstate standardization system" (GOST 1.) or "Standardization in the Russian Federation" (GOST R 1.). The procedure of the development of terms and definitions standards is prescribed by the guidelines [7]. These provisions will be considered in the paper in relation to a terminology standard for dependability. The description will be supported by examples from the experience related to the development of such standards.

Legacy

One of the principles of standardization specified by Article 4 of the Federal law "On standardization in the Russian Federation" is the provision of the continuity of activities in the area of standardization. The first general terminology standard for dependability in technics GOST 13377–67 was adopted in the USSR over half a century ago. It was consecutively replaced by GOST 13377–75, GOST 27.002–83, GOST 27.002–89, GOST R 27.002–2009 and GOST 27.002–2015. In this row GOST R 27.002–2009 stands out (its specifics will be considered later), yet all others maintained legacy to its predecessors. Of course, each new standard introduced new terms and elaborated some definitions, otherwise it would have not made sense to adopt it, nonetheless some basic provisions were kept intact.

For information the table contains the number of terms used in each of the mentioned standards (as well as in the international standards considered below). It is evident that GOST R 27.002–2009 stands out for this parameter as well, with the number of terms in it exceeding the boundary of 200 units specified in [7].

Number of terms in the standards

Standard	Number of terms
GOST 13377–67	24
GOST 13377–75	86
GOST 27.002–83	89
GOST 27.002–89	116
GOST R 27.002–2009	212
GOST 27.002–2015	146
IEC 60050-191:1990	244 (only terms related to dependability considered)
IEC 60050-192:2015	260

In the author's opinion, the basic provisions maintained in the Russian standards are as follows:

1. The definition of dependability as the *property* of an item (product in GOST 13377–67, the relationship between these notions will be considered below).

2. The consideration of dependability in the conditions of *an item's application (use), maintenance and repair, storage and transportation.*

3. The definition of dependability as an integrated property that can incorporate several simpler properties: *reliability, maintainability, durability and storability*.

4. The distinction of two pairs of opposite states of an item: *up state – down state* and *perfect state – imperfect state*.

5. The presence of several *integrated dependability measures* apart from the availability factor: *total availability (utilization) factor*, *interval availability factor* (since 1975), *effectiveness retention (efficiency) ratio* (since 1983).

Alignment with international standards

One of the objectives of standardization as specified in the Federal law "On standardization in the Russian Federation" (Article 3) is the facilitation of the Russian Federation integration into the global economy and the international systems of standardization as an equal partner. In accordance with [7, Par. 3.12], one of the tasks of standardization in scientific and technical terminology is the harmonization (the provision of alignment) of scientific and technical terminology at the national and international levels. Therefore, it is recommended to use terminology standards and vocabularies of international organizations (ISO, IEC, etc.) to the maximum extent practicable in order to provide terminology support for the Russian national standardization system, and special section 8 is devoted to this topic in [7]. As stated therein, the application of international standards enables the achievement of several objectives. One of them is the use of the benefits of scientific and technological progress. Indeed, most of the advanced technologies, technical solutions, their hardware and software implementations come to us from abroad. Naturally, related terms come along with them as well. Another objective is to standardize terminology used within the framework of trade, economical, scientific and technological cooperation with other countries.

Also, a substantial part of our standards is currently harmonized with international standards. Therefore, even if the development of a terminology standard in dependability is not going to take an analogous international standard into account by any means, the terms and definitions from it will anyway find their way into our country along with other standards, this leading to undesirable collisions. Let us consider a typical example. In a widely used Russian standard [8], the term "dependability" has the following definition: "ability to perform as and when required" (its source will be provided below).

Unfortunately, the complete harmonization of the national terminology standard in dependability with an international standard is hardly possible at present, since it will be in plain contradiction to the legacy principle. The point is that the standardization of dependability terminology in our country began earlier than globally, though our representatives did not take any active part in the work of respective international organizations, so our experience has not practically been taken into account, and this has resulted in the fact that the Russian and international standards differ in some important positions (examples will be provided below). Thus, it is reasonable, on the one hand, to go step by step in the direction of alignment of the Russian terminology with the international one, and on the other hand, to make attempts to include those terms from our standard into the international one, which are missing therein.

A major role in dependability standardization belongs to IEC, namely to its Technical Committee (TC) 56, which is called "Dependability". By agreement with ISO, it is horizontal, i.e. it develops standards for all areas of technics, not only for electrotechnics. Those who are interested in its history and activities, can be referred to papers [9] and [10] (the author of the first one was the TC 56 chairman at the period of 2008–2017, and the author of the second one is the acting chairman); in Russian there is a publication [11] reflecting its authors' work experience in TC 56.

The current international terminology standard in dependability [12] represents the part 192 of the International Electrotechnical Vocabulary (IEV). IEV contains all the IEC standardized terms and their definitions in English and French. It has a publicly available online version "Electropedia" (http://www.electropedia.org/), where one can also find equivalents of terms in other languages. In particular, terms in dependability are provided in other 9 languages (apart from English and French), but unfortunately, the Russian language is not among them. The overview of the standard [12] in Russian, its comparison with the previous version of a similar standard [13] and the Russian terminology standard is presented in [14].

None of the mentioned basic provisions of the Russian standards is fully in line with the international standards. Therein dependability and its constituents (reliability, maintainability, etc.) are defined as an item's abilities, rather than as its properties; the storage and transportation of an item

are not taken into account, thus storability not being incorporated into dependability; there are no analogs of perfect state and imperfect state, and no integrated dependability measures mentioned above. Nonetheless, as far as the relationship between a property and an ability is concerned, in the author's opinion, the difference is not so vital [2], and by the way, even in IEC TC 56, when defining dependability as the ability of an item, they say about it as a property [9].

It is [12] that was the source of the abovementioned definition of dependability from [8]. The thing is that standard [8] is identical to ISO 9000:2015, and during the development of this international standard they took the definition from [12] considering the major role of IEC in dependability standardization. By the way, it would be good for the developers of our standards to act in the same way, so that they not invent their own terms and definitions related to dependability, but rather take them from the terminology standard of the series "Dependability in technics".

The first attempt to find a compromise between legacy and alignment with an international standard was GOST R 27.002–2009, which was developed with the basic provisions of international standard [13] taken into account. Unfortunately, this attempt was a failure, as GOST R 27.002–2009 had a wide range of significant drawbacks.

A system of terms therein was poorly coherent and inconsistent. For instance, the definition of dependability taken from [13] used the term "maintenance support", whereas this term was not included into the standard. On the other hand, likewise in our previous standards, GOST R 27.002–2009 had the term "storability", though its relationship with dependability was absolutely unclear. Some of terms (e.g. "imperfect state") took on a meaning different from what was defined in previous national standards and became something common for specialists. For several terms taken from [13], bad Russian equivalents were chosen. Some definitions from [13] were translated with mistakes (omissions, wrong cases, etc.), resulting in distortion and ambiguity of the meaning. As was mentioned above, the number of terms therein is too large. Moreover, standard [13] taken as a basis had become obsolete by the time, and IEC TC 56 had been actively working over a new standard that was to replace it (unfortunately, the work took longer than it had been expected initially, and [12] was adopted only in 2015).

GOST R 27.002–2009 got severely criticized by the scientific and technical community, which resulted in the fact that Rosstandart made a decision to suspend GOST R 27.002–2009 and to renew the validity of the interstate standard GOST 27.002–89 (order dated 29.11.2012 № 1843-st). In parallel, they began developing a new terminology standard, which became the interstate standard GOST 27.002–2015. Unfortunately, while bringing this standard into force as a national standard of the Russian Federation (order dated 21.06.2016 № 654-st), Rosstandart did not cancel the contradicting GOST R 27.002–2009, as it should have been done according to Par. 6.2 of GOST R 1.8–2011 [14].

During the development of GOST 27.002–2015, a new attempt to find a compromise between legacy and alignment with IEC new standard [12] was made, however, compared to the previous time, the preference was given to legacy. At the same time, it included some terms from [12], which had been missing in our standards before.

Consistency with other general technical standards

One more principle of standardization specified by the Federal law "On standardization in the Russian Federation" is consistency of national standards. Indeed, contradictions between standards create difficulties for those who apply these standards ("What to believe?" [5]), shatter confidence and respect in the entire system of standardization. Therefore, a terminology standard in dependability ought to be consistent with basic general technical standards, in particular, with standards of "Unified system for design documentation" (Russian abbreviation ESKD, GOST 2.), "Unified system of technological documentation" (ESTD, GOST 3.), etc.

One may think that this requirement is obvious and should be clear for everyone. Unfortunately, in practice there have been cases when this principle was violated. For example, in GOST R 27.002–2009 the definition of the term "product" was fundamentally different from the definition of the same term in ESKD (in more detail it was covered in [16]).

The definition of dependability as a property is in line with this principle. Indeed, a general technical standard [17] defines the quality of products as the entirety of a product's properties underlying its capability to satisfy certain needs as to its purpose. One of these properties is dependability.

It is worth noting that consistency of standards should be provided by both ways. General terms used in dependability standards should have the same meaning as in basic general technical standards where these terms are in place. On the other hand, dependability terms in all standards should be used in line with the way they are defined in the terminology standard of the standards series "Dependability in technics".

Internal consistency and logical coherence

Even more obvious is the requirement for internal consistency and logical coherence of a standard itself. Unfortunately, sometimes this principle was violated as well. For example, in GOST R 27.002–2009 the terms "availability state" and "availability time" were by no means related to availability measures (availability factor, etc.); "perfect state" and "imperfect state" were not opposite to each other, whereas "imperfect state" was opposed by "on-call state".

There is also some logical inconsistency in [12], which is admitted even by its developers [9]. Dependability is therein defined as an ability (property) of an item, although it includes maintenance support performance, which is defined as the efficiency of an organization in relation to maintenance support, i.e. is not an item's property, but rather conditions under which it is used.

Generality and universality

The fact that a general dependability standard should be applicable to all branches of technics requires the maximum generality and universality of terms and definitions to be specified in it. They should be specified in such a way that they could be used in all industries. According to [7, Par. 6.3], the attributes introduced into a definition should be inherent in all objects comprising the scope of a term.

Of course, the application in various industries can necessitate further specification and elaboration. Therefore, at the beginning of all recent standards (since 1989) it is said that definitions specified therein can be changed if necessary, by introducing derived attributes, elaborating the meaning of terms used therein, specifying objects comprising the scope of a defined term. However, these changes should not modify the scope of terms defined in a standard.

Using this line of thinking, let us take a look at what the term "dependability" is related to, i.e. whose property or ability it is. For that purpose, GOST 13377–67 and GOST R 27.002–2009 used the term "product", while all others of our standards used the term "item". The scope of these terms and the relationship between them were analyzed in detail in [16], therefore, the issue will be considered briefly here.

Quite naturally that GOST 13377–67 and GOST R 27.002–2009 used rather general definitions of a product, the first one in its preamble, the second one as one of the main terms. However, they were different from the term in ESKD and, consequently, did not satisfy the principle of consistency. That is why there used to be cases when representatives of some industries dealing with buildings and constructions, power supply systems, telecommunications networks, etc. said that the standard did not apply to them, since their objects were not products. And they meant a product in a typical way, i.e. in line with the definition of ESKD.

Therefore, in all others of our standards the definition of dependability and other terms is given relation to an item (ob'ekt in Russian). By the way, among the languages in Electropedia, in which dependability terminology is provided, there are two Slavonic languages, namely Czech and Polish, and in those languages the terms *objekt* and *obiekt* are used respectively for this notion. At the same time, since a product is a specific case of an item, it is not prohibited to write about dependability or failures of products in industry documents, if the scope of consideration is limited to them.

The definition of the term "dependability" should also be general and universal to the maximum extent. Various approaches to the specification of such a definition were analyzed in detail in [2]. In particular, it compared two types of definitions: parametric and functional definitions. It was noted that a functional definition is more general, i.e. it is suitable for a wider range of situations. The possibility of cases when a parametric definition is not reasonable or possible was already mentioned in GOST 27.002–89 in the explanatory note to the term "dependability", though a parametric definition was used therein as a basic one, while a functional definition was provided just in the explanatory note. Therefore, a generality principle was violated in this case: the definition contained parameters pertaining not to all objects. The developers of GOST 27.002–2015 decided to follow this principle and, thus, chose a functional definition as a basic one, while providing a parametric definition in one of the notes to the term "dependability". Such a choice was also a step in the direction of alignment with [12] (the definition of dependability from it was given above).

When discussing this aspect, sometime one has to come across with the position that can be called "industrial egocentrism". Discussants request that a standard should incorporate the terms and definitions that are used in their industry and do not take the arguments of other industries' representatives, for whom such definitions are not suitable, refuse to reach a compromise by finding mutually acceptable universal solutions. In general, the importance of compromises in standardization (and not limited to it) was well written about in [18].

Conclusions

The paper has formulated the main principles that a general dependability terminology standard should conform to: continuity in relation to previous similar national standards, alignment with the international IEC standard, consistency with other general technical standards, internal consistency and logical coherence, generality and universality to meet the needs of all industries.

The author appeals to all concerned specialists to share their opinions and make constructive suggestions about these principles.

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The author's contribution

Netes V.A. analyzed Russian and international dependability terminology standards and proposals for their improvement, identified their shortcomings and deviations from the requirements of regulatory documents for standardization, formulated the main principles a general dependability terminology standard is to comply with.