Organization of a modular information presentation to verify measuring instruments in a modern enterprise

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Abstract. The article is devoted to the issue of using a system of modular presentation of verification information. It is noted that automation plays a large role at the present stage of enterprise development. The automation methods in the metrological field of enterprise functioning are revealed. Inconsistencies that potentially arise when providing verification documentation to the auditor in the case of using a digital system for presenting information on verification of measuring instruments are indicated. It is formulated that the use of a modular digital system for presenting information on the verification of measuring instruments, integrated into the digital environment of an enterprise and controlled by the state departmental body, can have a beneficial effect on the activities of the organization as a whole.

In modern conditions of increasing the role and value of information in the life processes of an enterprise, one of the key factors for its confident development is automation of the processes of accumulation, collection, storage, interpretation, analysis and usage of various production data. Efficiency of execution of such processes is also an important factor, since temporary resources have always been one of the most expensive assets of the enterprise. The client is not ready to pay for the downtime of technological and other internal processes at the enterprise, respectively, low operational efficiency directly affects the competitiveness of the organization. One of the key resources for the enterprise now is information [1]. In this regard, any information should be reliably protected from unauthorized access, especially if it contains information regarding trade secrets or other data important for the functioning of the enterprise.

To increase efficiency of the process functioning at the enterprise, to reduce the influence of the human factor and, as a result, to increase the number of suitable output products, various processes of automation of the organization’s activity are used [2]. Automation covers almost any production processes: assembly, manufacturing, repair, transportation of raw materials, metrological and acceptance tests, design, control of product parameters and many others. Without the use of automation processes, it is impossible to imagine modern production with its huge array of data and technological operations [3]. Besides, automation processes are widely used in metrological support of the organization.

The processes of metrological support include various components: verification or calibration of measuring instruments, metrological examination of documentation, metrological supervision and control, selection of measuring instruments based on the needs of the organization and the requirements of technological processes, etc. If we examine directly the verification of measuring instruments, then it can be noted that, based on the verification results, a rather large volume of
documents is generated containing information about metrological characteristics of the measuring instrument, time and date of calibration, reference instruments, the employee who performed the verification, his verification mark and other information. Even if the organization is not accredited for the right to carry out verification actions and is forced to give its measuring instruments to third-party authorized institutions for the right to verify, all verification information is still transmitted to the metrology department of such an organization. In any case, the processes of processing, storage and analysis of the information received, due to an increase in the volume and variety of verification work, a decrease in the number of technical specialists, are becoming more and more laborious. In this regard, the use of various automation tools, including a single information database, which contains all the information about the verification/calibration of measuring instruments, seems appropriate [4].

Now, there are various systems for automating the presentation of information on the verification of measuring instruments at the enterprise [5]. Basically, such systems are based on recording information in an internal database and provide the capability to store verification protocols, information on the date of the previous and the next verification, information on the reasons for non-compliance if the measuring instrument is unsuitable for further use, information about the verification agent and other information. There is a possibility of compiling reports on the number of rejected measuring instruments, the number of measuring instruments required for submission to verification by a certain date, and compiling lists considering various criteria.

However, such systems have several disadvantages. The management of such systems is entrusted to employees of the organization’s metrology department, which does not exclude the possibility of unintentional or deliberate changes to certain data entered into such a system. Thus, for example, in the case of an audit by a higher authority, the employees of the organization being audited can make changes to such a system for submitting verification information to hide certain discrepancies to avoid remarks. In addition, when conducting an external audit, other inconsistencies are possible when providing information about the verification of measuring instruments to the inspector. In order to examine in more detail the possible reasons for the remarks from the inspector during the audit of the verification documentation, a ‘cause-effect’ diagram was constructed, which is shown in Figure 1.

The analysis of factors showed that, mainly, the human factor has a negative impact on the process, as well as the fact that the information delivery system stores data on the internal server of the
enterprise. Thus, in the event of a power failure, the data may be lost, or their presentation to the auditor will be difficult.

In order to assess how strongly these factors influence the audit process, an FMEA analysis of providing documentation on the verification of measuring instruments for audit in electronic form was carried out, a fragment of which is presented in Table 1.

Table 1. Fragment of FMEA analysis of conducting audit of verification documentation.

| №  | Operation                          | Potential defect       | Potential reason            | Potential consequences | A  | B  | E  | RPZ |
|----|-----------------------------------|------------------------|-----------------------------|------------------------|----|----|----|-----|
| 13 | document request                  | incorrect document provided | employee inattention         | temporary losses       | 2  | 8  | 4  | 64  |
| 15 | provision of the required document| incomplete document    | employee negligence          | temporary and financial losses | 2  | 8  | 3  | 48  |
| 16 | verification by the auditor of document information | mismatch detected | Inattention of an employee when entering information | auditor’s remarks; temporary and financial losses | 2  | 8  | 5  | 80  |
| 17 | preparation of an audit report    | the act is not drawn up correctly | Audit Commission inattention | temporary losses       | 2  | 2  | 5  | 20  |

In Table 1, the values of column A characterize the probability of non-compliance, the values in column B reflect the severity of the consequences for the consumer and the values of column E - the probability of non-detection of the non-compliance before it occurs. A value of 1 corresponds to the lowest characteristic value, and the value of 10 corresponds to the highest one. The risk factor of the operation is visualized by the value of RPZ column and is obtained by adding up the values of columns A, B and E. Thus, from the given fragment we can conclude that the operation of increased risk is the operation of the auditor checking the document information since in case of employee error when drafting a document and detecting such an error, the auditor will give a remark.

To evaluate the correctness of certain RPZ indicators, a factor analysis is necessary. The purpose of factor analysis is to clarify the final value of the parameter A, B and E obtained by the expert assessment method during FMEA analysis. In other words, factor analysis is a method that allows you to determine and evaluate the degree of mutual influence of variables. After conducting a factor analysis of the operation of the auditor checking the document information, the RPZ coefficient turned out to be 83, which confirms the correctness of the calculation in the FMEA analysis.

Consequently, in order to avoid inconsistencies associated with the potential for intentional or accidental change of verification data, errors associated with entering information into the verification data presentation system, depending on the energy supply of the enterprise, it seems relevant to introduce a unified secure module verification database system in digital form with remote access. This kind of system stores information on cloud storage, which guarantees independence from the energy supply of the enterprise. To ensure the accuracy of the data entered into the system, verification information is entered only by authorized employees of that organization, which is accredited for the right to conduct verification of measuring instruments by state bodies. In the event that a private organization also has the right to carry out verification, the information after the verification of the measuring instrument is entered into this system under the remote control of an employee of an
authorized state organization for the calibration of measuring instruments, who, using the automated software of the system, controls correctness and reliability of the entered data. Thus, it becomes possible to ensure the reliability, transparency and verification of the provision of verification information, including the case of an audit of the metrological activity of the organization. Also, there is the possibility of correlating such a database with the system of a single digital environment of an enterprise or holding. In this case, there are great opportunities for interorganizational integration to increase the operational efficiency of all enterprises included in a single information space. To obtain information about the passage of a verification procedure by a measuring instrument, there is no need to contact an adjacent company, look for the desired department or a responsible person [6]. The system allows you to receive such information quickly from your workplace. In addition, in the case of integration of such a digital modular system with automation systems for enterprise management, prerequisites are created for the creation of a single digital space of the enterprise, the organization’s digital double [7]. For example, if you provide a correlation between the system under consideration and the optimum equipment work load system (MES-system), then the latter, receiving information from the calibration database, will be able to efficiently recalculate the production schedule in case of failure of any measuring instrument taking into account existing accepted and efficient instruments, taking into account the correspondence of their metrological characteristics. Such interconnection will increase the efficiency and reliability of managerial decision-making, reduce the human factor influence, and ensure transparency in the functioning of the enterprise [8].

Also, it is important that the considered system of modular presentation of information on measuring instruments verification has a high degree of autonomy. This makes it possible to use its functionality even in the event of force majeure situations that may cause the enterprise to not be able to function normally [9]. It has to be noted that the use of a system of modular presentation of verification information serves as a means of increasing the efficiency of not only the metrological service of the enterprise, but also increases competitiveness of the entire organization. The system enables you to uniquely identify data related to a particular measuring instrument, is a means of ensuring reliability, transparency and verification of the information stored in it. The system is one of the components of a single digital space of the enterprise, and provides opportunities for the development of interorganizational interactions in the context of digital transformation of enterprises, which is one of the key advantages at the present stage of the information era.

References
[1] Ponomarev K.S., Feofanov A.N., Grishina T.G. Digital production double strategy as a method of digital transformation of the enterprise / Vestnik sovremennyh tehnologij [Bulletin of modern technologies]. - 2019. No. 4 (16) - pp. 23 - 30.
[2] Ponomarev K.S., Feofanov A.N., Grishina T.G. Digital transformation of enterprises is the key to further development of the organization / Nauka segodnja: vyzyvy, perspektivy i vozmozhnosti: materialy mezhunarodnoj nauchno-prakticheskoy konferencii [Science today: challenges, prospects and opportunities: materials of the international scientific and practical conference], Vologda, 11.12.2019: in 2 parts. Part 2. - Vologda: OOO «Marker» Publ., 2019. - 112 p.
[3] Solomentsev Yu. M. Effective production management - the potential basis of a technological system / Yu. M. Solomentsev, E. B. Frolov, A. N. Feofanov // Vestnik mashinostroenija [Bulletin of mechanical engineering]. - 2017. No. 5. - pp. 84-86.
[4] Development of algorithmic and digital solutions for an adaptive methodology for calculating reliability of calibration results of measuring instruments: Dissertation of the candidate of technical sciences: 05.11.15 / Suleiman Imad Ahmad; [Place of defense: N.E. Bauman Moscow State Technical University].- Moscow, 2012.- 144 p.
[5] Agamalov Yu.R. New opportunities for automation of verification and calibration of digital electrical measuring instruments / Yu.R. Agamalov // Avtomatizacija v promyshlennosti
[Automation in industry]. - 2012. No 12. - pp. 57 - 61.

[6] Baranov P.F., Borikov N.V. Remote verification and calibration of measuring instruments / P.F. Baranov, N.V. Borikov / Kontrol. Diagnostika [Control. Diagnosis] - 2012. No. 11 - pp. 13 - 16

[7] Automated verification of compliance of technical documentation of an enterprise in the conditions of digital technology. Alexander Feofanov. Nataliya Bondarchuk. MATEC Web of Conferences, 2018, 224: 02105.

[8] Solomentsev Y.M., Frolov E.B. & Feofanov A.N. MES-based management of manufacturing processes. Russ. Engin. Res. 37, 950–953 (2017).

[9] Solomentsev Yu. M. Operational planning and management of machine-building production on the basis of executive production systems / Yu.M. Solomentsev, E.B. Frolov, A.N. Feofanov // Vestnik mashinostroeniya [Bulletin of mechanical engineering]. - 2017. No. 8. - pp. 41-43