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ASSESS THE ADEQUACY OF MEASUREMENTS IN TEST LABORATORIES BASED ON UNCERTAINTY AND RISKS

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Abstract. This paper aims to assess the conformity of measurements, taking into account inaccuracies and risks, in order to strengthen the confidence in the activities of laboratories. Risks play an important role in the process of calculating uncertainties and inaccuracies in decision-making or conformity assessment of test results in accordance with the requirements of ISO 17025-2017. Nowadays, the use of measurement results in graphs is an effective tool. In this paper, the differences between the results of power consumption measurements in the testing of electrical products are reflected and analyzed on the Schuhart map.

Keywords: uncertainty, risk, system, electrical products, electrical engineering, Schuhart map, ISO (International Organization for Standardization).

Introduction

It should be borne in mind that the laboratory must develop a system capable of ensuring and demonstrating continuous compliance with the requirements of ISO 17025-2017, as well as guarantee the quality of laboratory results. [1] The laboratory should have a principle to monitor the accuracy of the results. The final results should be recorded in a way that allows trends to be identified, and, where applicable in practice, statistical methods should be used to analyze the results. [2] Expression of statistical methods on the basis of excel program expands the possibilities of research. Statistical methods help to strengthen the laboratory activities, taking into account the risks in the measurements. Today, the demand for electrical products is growing. Checking the safety and quality of electrical products on the basis of standard requirements is a modern requirement. The main task of testing laboratories is to check the power consumption of electrical products and to ensure that they do not exceed or exceed the requirements set in the production. Consumption power is a key indicator of an electrical tool because this parameter is of economic importance. The main research of this paper has taken into account the...
inaccuracies and risks in the measurement of consumption power. The monitoring method has many advantages in ensuring the reliability of measurements. This monitoring should be planned and analyzed, and when possible, should include, but not be limited to: At the time of writing, the standards have been studied in detail, and statistical methods have been used to ensure accuracy and precision in the test laboratories of GOST 5725.6-2002.

**Research methods**

Statistical methods are a more effective strategy to prevent losses, primarily to avoid producing the wrong products. Such a strategy involves collecting information about the process, analyzing it, and taking timely action to improve the process itself [8]. The control table was proposed in 1924 by Dr. Walter Schuhart as a graphical tool for applying statistical principles to process management. The control diagram theory distinguishes between two types of variability or variability. Statistical process control is a methodology for setting up and maintaining a process at an acceptable and stable level to ensure that products and services meet established requirements. The main statistical tool of process control is the control scheme, viz. a graphical method of presenting and comparing data based on the analysis of data from serial samples, reflecting the current state of the process, the boundaries set based on the specific variability of the process. The control diagram method first helps to assess whether the process has reached a manageable state or whether it continues in that state.

Schuhart control diagram is a graph used to show a statistical scale derived from quantitative or alternative data. When using a sugar card, we need working parameters. The Shuhart map has statistically defined control boundaries on either side of the center line [7].

- **UCL** - upper limit control line \((3\sigma + \bar{X})\)
- **LCL** - lower boundary control line \((\bar{X} - 3\sigma)\)
- \(\bar{X} - 2\sigma\) - bottom control line
- \(\bar{X} + 2\sigma\) - top control line
- \(\bar{X} + 2\sigma\) - Average quadratic deviation
- \(\bar{X} - center line (average value of parallel values)\)

\[
\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - y_i)^2}{2n}}
\]  \(1\)

- **\(X_i\)** - measurement result
- **\(Y_i\)** - re-measurement result
- **n** - number of measurements

Evaluation of measurement uncertainty is a key working parameter in ensuring the conformity of products based on established requirements.
Uncertainty - A parameter that describes the distribution of values that is related to the measurement result and can be related based on the measured value. [9]

\[ u(x_i) = u_X(x_i) = \sqrt{\frac{1}{n(n-1)} \sum_{i=1}^{n} (x_i - \bar{x})^2} \]  

(2)

n- number of measurements

X_i- the result of measurements

\( \bar{x} \)- average value

**Research-based results**

The results of the research in this article were obtained in the testing laboratory of electrical equipment LLC "GLOBAL INVESTMENT SYSTEMS". The research was carried out on refrigerated products entering the territory of the Republic of Uzbekistan as an object of study, and the results were processed, used and documented in the assessment of conformity.

**Table 1**

<table>
<thead>
<tr>
<th>Quality indicator</th>
<th>Power consumption (refrigerator)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit of measurement</td>
<td>W (VATT)</td>
</tr>
<tr>
<td>Test requirement</td>
<td>Gost 60335-2015 p.10</td>
</tr>
<tr>
<td>Trial period</td>
<td>08.11.2021-18.11.2021 y</td>
</tr>
</tbody>
</table>

| Laboratory | Electrical Engineering Testing Laboratory |

<table>
<thead>
<tr>
<th>Day</th>
<th>( x_i )</th>
<th>( y_i )</th>
<th>( \bar{x} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>08.11.2021 y.</td>
<td>92,5</td>
<td>93,5</td>
<td>93</td>
</tr>
<tr>
<td>09.11.2021 y.</td>
<td>98,5</td>
<td>97,5</td>
<td>98</td>
</tr>
<tr>
<td>10.11.2021 y.</td>
<td>101,2</td>
<td>96,4</td>
<td>98,8</td>
</tr>
<tr>
<td>11.11.2021 y.</td>
<td>90</td>
<td>95,4</td>
<td>92,7</td>
</tr>
<tr>
<td>12.11.2021 y.</td>
<td>97,8</td>
<td>92</td>
<td>94,9</td>
</tr>
<tr>
<td>13.11.2021 y.</td>
<td>101,2</td>
<td>96,4</td>
<td>98,8</td>
</tr>
<tr>
<td>15.11.2021 y.</td>
<td>96</td>
<td>94</td>
<td>95</td>
</tr>
<tr>
<td>16.11.2021 y.</td>
<td>89,8</td>
<td>92</td>
<td>90,9</td>
</tr>
<tr>
<td>17.11.2021 y.</td>
<td>94,6</td>
<td>98,2</td>
<td>96,4</td>
</tr>
<tr>
<td>18.11.2021 y.</td>
<td>105,4</td>
<td>105,8</td>
<td>105,6</td>
</tr>
<tr>
<td>19.11.2021 y.</td>
<td>86,8</td>
<td>96,4</td>
<td>91,6</td>
</tr>
<tr>
<td>20.11.2021 y.</td>
<td>100</td>
<td>98</td>
<td>99</td>
</tr>
<tr>
<td>22.11.2021 y.</td>
<td>92,4</td>
<td>90,8</td>
<td>91,6</td>
</tr>
<tr>
<td>23.11.2021 y.</td>
<td>96,4</td>
<td>90,4</td>
<td>93,4</td>
</tr>
<tr>
<td>24.11.2021 y.</td>
<td>90,8</td>
<td>98</td>
<td>94,8</td>
</tr>
</tbody>
</table>

\[ \sigma = 3.29 \text{ The value found by the above formula.} \]

\[ 3^*\sigma + \bar{x} = 10.87+95.6=106.47 \text{ W} \]

\[ \bar{x} - 3^*\sigma = 95.6-10.87=84.73 \]

\[ \bar{x} - 2^*\sigma = 95.6-6.58=89.02 \]

\[ \bar{x} + 2^*\sigma = 95.6+6.58=102.18 \]
The results obtained from 08.11.2021 to 24.11.2021 are reflected in the map shown above, which shows that the results obtained on 18.11.2021 have a large deviation. Therefore, these results cast doubt on the reliability of the operator or the results. The field between $\bar{X} + 2\sigma$ and $\bar{X} + 3\sigma$ represents the presence of danger. Risk assessment in measurements represents the excellence of test laboratories. [8]

$\bar{X} \pm U$

95.6 ± 3.90

The product is marked on the packaging as 110 W/h. Taking into account the uncertainty, we assess the conformity of the product. The ILAS G8 is used and documented in the conformity assessment in the laboratory of electrical engineering.
Based on the ILAS G8, the compatibility confidence limit is set at 95%. The danger area is marked as $1 \times U$. This method of matching is called binary. The advantage of conformity assessment based on the binary method is that the risk area can be controlled. Our results are between 91.7 w and 99.5 w.

**Conclusion and recommendation**

Conformity assessment is important in improving the reliability of measurement results in test laboratories based on ISO 17025-2017. The Declaration of Conformity applies to any decision rules that apply safeguards to improve or establish a minimum risk of mishandling. When a customer hands over an item to a testing lab, they only care about the “risk of mishandling by the consumer”. However, when a laboratory returns a product as rejected, the customer must inspect the products manufactured by their organization, as this can lead to the return / subsequent recall of an expensive product [6] per statistical method. Based on these methods, we can test the qualifications of laboratory staff in the perfect implementation of these rules. We recommend GOST 17034 -2017.

The conclusion is as follows:
- We can clearly see the differences between the results obtained during the testing of laboratory products
- It should be noted that the results obtained in the Act, taking into account the average value and uncertainty, are not at risk of conformity assessment, and these requirements ensure that they meet international standards.

**References**

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7. ISO 7870-1:2014 Control Charts

8. Control charts and control materials in internal quality control in food chemical laboratories (NMKL Procedures No. 3, 2nd Ed., 2016)
