further improvement of the standardization system and for raising the metrological provisions level in measuring the composition of materials in the industry as a whole.

LITERATURE CITED
1. V. I. Paneva et al., Izmeritel'naya Tekh., No. 11 (1975).

METROLOGICAL EXAMINATION OF TECHNOLOGICAL DOCUMENTS
(FROM THE EXPERIENCE OF THE ALTAI ENGINE PLANT)

M. Ya. Gel'fand, V. D. Margol'f, and L. S. Solovov

Experience has shown that a centralized metrological service plays an important part in improving testing technology. Moreover, the statistical analysis and testing technology laboratory then becomes the leading agency in generalizing the results of the work on optimizing testing technology by means of special charts. At the same time a measuring equipment's analyzing and registering chart is compiled for each technological regulation of machining.

The analysis is based on a standard [1]. The chart (Table 1) provides data suitable for comparing the tested parameter's tolerance to the maximum measurement error and for determining a correct choice of measuring equipment and consequences of its inaccurate selection (Table 1, columns 3-6, 10, and 11). The data on the testing volume, measuring time, number of measuring instruments, and periodicity of testing incorporated in this chart serve to eval-

### TABLE 1

<table>
<thead>
<tr>
<th>Operation No.</th>
<th>Tested parameter</th>
<th>Measurement requirement</th>
<th>Measurement equipment</th>
<th>Specification, tolerance class and scale factor</th>
<th>Max. measure. error</th>
<th>No. of measuring devices</th>
<th>Duration of a single parameter measurement</th>
<th>No. of incorrect measurements</th>
<th>No. of rejected components</th>
</tr>
</thead>
<tbody>
<tr>
<td>330</td>
<td>105-0.023</td>
<td>6</td>
<td>Limit gauge</td>
<td>8113-4535</td>
<td>21</td>
<td>100</td>
<td>4.61</td>
<td>6.9</td>
<td>Daily</td>
</tr>
<tr>
<td>330*</td>
<td>105-0.023</td>
<td>6</td>
<td>Process-control instr.</td>
<td>BV 4100 (AK-3)</td>
<td>4</td>
<td>100</td>
<td>2.68</td>
<td>9.6</td>
<td>Once every 3 mo.</td>
</tr>
<tr>
<td>320x</td>
<td>165-0.023</td>
<td>6</td>
<td>Limit gauge</td>
<td>8113-4535</td>
<td>21</td>
<td>100</td>
<td>0.61</td>
<td>6.9</td>
<td>Daily</td>
</tr>
<tr>
<td>330g</td>
<td>105-0.023</td>
<td>6</td>
<td>Ext. lever gauge Sr 100-125, scale factor 0.005mm</td>
<td>GOST 110096-64</td>
<td>6</td>
<td>5</td>
<td>4.12</td>
<td>3.7</td>
<td>Once per week</td>
</tr>
</tbody>
</table>

*Operations denoted with an asterisk refer to the recommended measuring devices.

Translated from Izmeritel'naya Tekh., No. 4, pp. 15-17, April, 1976.
Table 2

<table>
<thead>
<tr>
<th>Component’s index and name</th>
<th>Chart of metrological provisions for producing crankshafts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>number of tested parameters appearing on the drawing and in the regulation</td>
</tr>
<tr>
<td></td>
<td>lengths</td>
</tr>
<tr>
<td>01-0401 Crankshafts</td>
<td>63</td>
</tr>
</tbody>
</table>

If an incorrectly allocated measuring instrument is detected, the full characteristics of the recommended replacement instrument are entered into the chart. The expected saving due to its use and the consequent reduction of "false" rejects, rising efficiency, or decreasing volume of testing are also indicated (Table 1, column 13).

As an example let us analyze the technological and testing operation in machining a crankshaft.

The crank journal diameter of 105-0.023 mm is tested in finishing grinding by means of a limit gauge. The machine has then to be stopped several times for measurements. Data on norms for the value of the limit-gauge measurement error are lacking [2, 3].

Let us make a tentative estimate [4, 5]

$$\Delta \text{lim} = \Sigma \Delta Qn + \Delta \text{lim}_r,$$

where $\Delta \text{lim}$ is the limit-gauge measurement error; $\Delta \text{lim}_r$ is the random component of the measurement error; $\Sigma \Delta Qn$ is its systematic component.

$$\Delta \text{lim}_r = \pm \sqrt{\Delta^2 \text{lim}_1 + \Delta^2 \text{lim}_2 + \Delta^2 \text{lim}_3},$$

where $\Delta \text{lim}_1$, $\Delta \text{lim}_2$, and $\Delta \text{lim}_3$ are the measurement error’s random components due respectively to the heat of the operator’s hands, the temperature difference between the instrument and the object, and the type of contact between the measuring device and the measured object.

For a 105-mm diameter snap gauge $\Delta \text{lim}_1 = 14 \mu$, $\Delta \text{lim}_2 = 5.7 \mu$, $\Delta \text{lim}_3 = 2 \mu$ and, therefore, $\Delta \text{lim}_r = 15.3 \mu$,

$$\Sigma \Delta Qn = \frac{\delta(E-GO) + \delta(E-NG)}{2},$$

where $\delta(E-GO)$ is the tolerance for the effective GO part of the gauge; $\delta(E-NG)$ is the tolerance for the effective NO GO part of the gauge.

According to [4, 6] and the formulas (2) and (3) we find that $\Sigma \Delta Qn = 5.7 \mu$ and $\Delta \text{lim}_r = 21 \mu$.

For testing a 105-mm diameter shaft with a tolerance of 23 $\mu$ it is recommended to use measuring devices whose maximum error does not exceed 6 $\mu$ [1]. Therefore, the above limit gauge has not been correctly allocated. Its application when the acceptance limits coincide with the normalized maximum value of the tested diameter can lead to 6% of components being incorrectly accepted and 9% incorrectly rejected in a tested batch [7].

Without considering the principles for determining the relative volume of testing, let us note in particular that the crank journal dimension is one of the most vital crankshaft