



SSU 3499-97

STATE STANDARD OF UKRAINE
STEEL MILLING BALLS FOR BALL MILLS
Specifications

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PREFACE

1. The standard was DEVELOPED and INTRODUCED by Ukrainian State Research Institute of Metals, TK 2.
2. The standard was APPROVED and IMPLEMENTED by the Order No. 52 of State Standardization Body of Ukraine dated January 31st, 1997.
3. The standard was implemented for the first time.
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Date of validity:1998.01.01

1. FIELD OF APPLICATION

This standard is applied to milling balls with diameter of 15-120 mm made of low alloy carbon steel or alloy carbon steel using methods of cogging, beating out and pressing and used for milling of iron stone, coal, cement and other materials in ball mills.

2. NORMATIVE REFERENCES

This standard has the references on the following documents:

GOST 12.2.003-91 Occupational safety standard system. Industrial equipment. General safety requirements.

GOST 12.2.094-83 Occupational safety standard system. Rolling equipment. General safety requirements.

GOST 12.3.002-75 Occupational safety standard system. Manufacturing processes. General safety requirements.

GOST 17.0.0.01-76 System of standards in nature protection and improving utilization of nature resources. General provisions.

GOST 166-89 Vernier calipers. Specifications.

GOST 5950-73 Bars and strips of tool alloyed steel. Specifications.

GOST 9012-59 Metals. Method of Brinell hardness measurement.

GOST 9013-59 Metals. Method of Rockwell hardness measurement.

GOST 14192-77 Marking of cargo.

GOST 21650-76 Means of fastening tied and break bulk cargoes in the local units. General requirements.

3. CLASSIFICATION, BASIC PARAMETERS AND DIMENSIONS

3.1. There are following groups of balls hardness:

- 1- normal hardness;
- 2- increased hardness;
- 3- high hardness;
- 4- high hardness with increased hardening-zone depth;
- 5- ultra high hardness with increased hardening-zone depth

3.2. Dimensions, limit deviations, nominal volumes and weights of the balls shall comply with the following values stated in the Table 1.

Table 1

Rated diameter, mm	Nominal diameter, mm	Limit deviations from the nominal diameter, mm	Calculated nominal volume, cm ³	Calculated nominal weight, kg
15	15.0	±1.0	1.76	0.014
20	20.0		4.18	0.033
25	25.0		8.18	0.064
30	31.5	±2.0	16.4	0.128
35	36.5		25.4	0.199
40	41.5		37.4	0.294
45	46.5		52.6	0.413
50	52.0	±3.0	74	0.58
60	62.0		125	0.98
70	73.0		204	1.60
80	83.0		299	2.35
90	94.0	±4.0	435	3.41
100	104.0		589	4.62
110	114.0	±5.0	776	6.09
120	125.0		1023	8.03

Note 1 Deviations from the ball geometric form shall not exceed limit deviations from the nominal diameter.

Note 2 Calculation of ball volume and weight is performed using values of nominal diameter provided that the steel density is 7.85 g/cm³.

3.3. Example of conventional values of a ball with diameter 60 mm and nominal hardness (1):
Ball 60-1 SSU3 499-97

4. TECHNICAL REQUIREMENTS

4.1. Characteristics.

4.1.1. The balls are manufactured in accordance with requirements of this standard on current manufacturing documents.

4.1.2. The balls of 1st and 2nd groups are manufactured of low alloy carbon steel and alloy carbon steel.

4.1.2.1. Carbon weight percentage in carbon steel shall be no less than:

- 0.40% for balls with rated diameter of 15-60 mm;
- 0.60% for balls with rated diameter of 70-120 mm.

4.1.2.2. Carbon equivalent of low alloy steel and alloy steel shall be no less than:

- 0.50% for balls with rated diameter of 15-60 mm provided that carbon weight percentage in steel shall be no less than 0.35%;
- 0.70% for balls with rated diameter of 70-120 mm provided that carbon weight percentage in steel shall be no less than 0.45%.

4.1.3. The balls of 3rd and 4th groups are manufactured of steel with carbon equivalent of no less than 0.75% and carbon weight percentage of no less than 0.60% provided that the required hardness is available.

4.1.4. Also the balls of the 2nd, 3rd, and 4th groups can be manufactured from low alloy steel and instrument steel in accordance with GOST 5950.

4.1.5. The balls of the 5th group are manufactured of steel, the carbon equivalent of which shall be no less than:

- 0.75% for balls with rated diameter of 15-60 mm provided that carbon weight percentage in steel shall be no less than 0.60%;
- 0.80% for balls with rated diameter of 70-120 mm provided that carbon weight percentage in steel shall be no less than 0.65%.

The balls hardness after thermal treatment shall comply with the following norms stated in the Table 2.

Table 2

Ball rated diameter, mm	Ball group						
	1	2	3	4		5	
	Hardness on ball surface, HRC ₃ /HB no less than				Hardness on ball depth of 0.5 of ball radius, HRC ₃ /HB no less than	Hardness on ball surface, HRC ₃ /HB no less than	Volume hardness, HRC ₃ /HB no less than
15-70	43/401	49/461	55/534	55/534	45/415	65/653	64/640
80-100	40/352	42/375	52/495	52/495	40/352	64/640	62/614
110-120	35/302	38/331	50/477	50/477	35/321	63/627	61/601

Note 1 The norms of volume hardness and hardness on ball depth of 0.5 of ball radius are optional ones till 99.01.01.

Note 2 Upon agreement of manufacturer and customer there can be allowed normalization of ball harness upper limit.

Note 3 The balls of the 1st group are manufactured upon agreement of manufacturer and customer.

4.1.7. The defects which make the balls bigger and exceed limit deviations are not allowed on ball surfaces.

4.2. Marking

4.2.1 Transport marking is performed in compliance with GOST 14192.

4.3. Packing

4.3.1. Packing is performed for the balls with diameter of less than 40 mm, and upon customer request – for the balls with a diameter of more than 40 mm.

The balls are packed in boxes or containers. The boxes are formed in unit loads in compliance with GOST 24597 and GOST 21650.

5. SAFETY REQUIREMENTS

Operation safety in ball rolling manufacturing is provided in compliance with requirements of GOST 12.2.003, GOST 12.2.094, GOST 12.3.002 and current safety regulations for metal industry plants and rolling manufacturing.

6. ENVIRONMENT PROTECTION REQUIREMENTS

Environment protection is provided in compliance requirements of GOST 17.0.0.01 taking into account specifications of manufacturing process at a plant.

7. ACCEPTANCE RULES

7.1. The balls are accepted by lots with total weight of not more than 150 t. The lot shall consist of balls with equal dimensions and group, as well as shall have the quality document with the following data:

- manufacturer name;
- conventional values of balls;
- lot number;
- hardness test results;
- quality control department stamp

7.2. In order to check dimensions, quality and surface hardness ten balls from not less than five places of a lot shall be taken.

In case of unsatisfactory results of a ball surface hardness control, this value is checked again using twenty balls of the same lot.

If during the repeat check more than two balls do not comply with the requirements, the whole lot is sorted and checked again.

The repeat check results are applied to the whole lot.

During the repeat check for hardness, the group of balls is determined in accordance with the results of this check. Based on the results of this repeat check, the lot can be assigned a lower group of hardness.

7.3. In order to control hardness on ball depth of 0.5 of ball radius of the 4th group and volume hardness of the 5th group there shall be taken three balls from three different places of every 20th lot. In case of unsatisfactory results at least at one of the balls, six balls of the same lot are checked again.

In case of unsatisfactory results of the repeat check, the acceptance-delivery checks are performed again until the satisfactory results for both lots are achieved.

7.4. No more than 10% of the selected balls for check are allowed not to comply with the requirements of this standard for dimensions and surface quality.

8. CONTROL METHODS

8.1. Balls dimensions are controlled by a vernier caliper in accordance with GOST 166 or by other tools which provide the required accuracy.

8.2. Balls hardness is measured according to the method of Rockwell in compliance with GOST 9013 or according to the method of Brinell in compliance with GOST 9012.

It is also possible to determine ball hardness with the help of other certified instruments.

8.2.1. Ball surface hardness is measured on two diametrically opposite grounds.

8.2.2. When measuring hardness according to the method of Rockwell, four measurements on each ground shall be performed.

First three measurements are performed on the corners of the imaginary equilateral triangle with a side of 6-8 mm. These are test measurements the results of which are not recorded in a test protocol.

The fourth measurement is performed in the triangle center. The result of this measurement is recorded into the test protocol.

8.2.3. When measuring hardness according to the method of Brinell, one measurement on each ground shall be performed and the result is recorded into the test protocol.

8.2.4. The hardness is determined as measurements average value of the whole balls for control.

8.2.5. The ball hardness on ball depth of 0.5 of ball radius is determined on one ground of a flat surface prepared in accordance with the requirements of GOST 9012 and GOST 9013 by removing metal of a ball to the required depth.

It is also possible to determine ball hardness on cross templates which are cut perpendicular to a technological "belt" of a ball the surface of which is prepared in accordance with the requirements of GOST 9012 and GOST 9013. Four hardness measurements on two mutual perpendicular lines are performed on a distance of 0.5 of ball radius. Minimal and maximal

values are not considered and the hardness is determined as an average value of the rest two measurements.

8.2.6. The volume hardness is determined on two mutual perpendicular directions on the templates cut from central part of a ball the surface of which is prepared in accordance with the requirements of GOST 9012 and GOST 9013 using the following formula:

$$VH = 0.289T_{nom.} + 0.436T_{0.25} + 0.203 T_{0.5} + 0.63 T_{0.75} + 0.009 T_{\mu}, (1) \text{ where:}$$

$T_{nom.}$, $T_{0.25}$, $T_{0.5}$, $T_{0.75}$ and T_{μ} - hardness values on a distance from a ball surface in radius parts which are determined in accordance with clause 8.2.5.

8.3. The equivalent carbon content of steel C_e in percentage form is calculated using the following formula:

$$C_e = C + \frac{Mn}{6} + \frac{Si}{24} + \frac{Cr}{5} + \frac{Ni}{40} + \frac{Cu}{40} + \frac{V}{14}, (2), \text{ where:}$$

C, Mn, Si, Cr, Ni, Cu, V – weight percentage of carbon, manganese, silicon, chrome, nickel, cuprum and vanadium.

8.4. Ball surface quality is controlled without using of magnifiers.

8.5. It is allowed using of statistical and nondestructive quality control methods of balls in accordance with current methods.

9. TRANSPORTATION AND STORAGE

9.1. The balls are transported by all means of transport in accordance with cargo transportation requirements approved by the appropriate body. The loading is performed in bulk.

At the customer's request, the balls are transported in covered trucks and vehicles with canopy body.

9.2. The balls shall be stored in bulk in places inaccessible for atmospheric precipitation.

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