I N T E R S T A T E S T A N D A R D

BARS, STRIPS AND HANKS MADE OF TOOL ALLOY STEEL

General Specifications

Official Edition
English Version Approved by Interstandard

INTERSTATE COUNCIL
FOR STANDARDIZATION, METROLOGY AND CERTIFICATION
Minsk

Introduction

1 DEVELOPED by Technical committee (TC 6) for standardization, by Ukrainian state scientific-and-research institute of special steels, alloys and ferroalloys (UkrNIIspezstal)

INTRODUCED by Ukraine State committee for standardization, metrology and certification

2 APPROVED by Interstate Council for standardization, metrology and certification (report No. 17, dated 22.06.2000)

Votes in favor:

State	National standards body
Republic of Belorussia	Belstandart
Republic of Kazakhstan	Gosstandart of the Republic of Kazakhstan
Republic of Kirghizia	Kirghizstandart
Russian Federation	Gosstandart of Russia
Turkmenistan	Head State Inspectorate of Turkmenistan
Ukraine	Gosstandart of Ukraine

3 Interstate Standard GOST 5950-2000 is introduced from 01.01.02 directly as State standard of the Russian Federation by Decree No. 220-ст, dated 04.06.01, of State Committee of the Russian Federation for Standardization and Metrology.

4 IN PLACE OF GOST 5950-73

Contents

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General specifications

Date of introduction form 01.01.02

1 Scope

This Standard applies to hot-rolled bars, strips and hanks, to forged bars and strips, to calibrated bars and hanks, to the bars (further referred to as the metal products) made of tool alloy steel with special surface finish.

This Standard applies to the *3Х2МНФ*, *4ХМНФС*, *9ХФМ* grade steels, to ingots, blooms, slabs, part blanks, forging, steel sheets, bands, pipes and other metal products specified by this Standard regarding norms of chemical composition.

2 Normative references

The following standards are referred to in this Standard:

GOST 1051-73 Rolled calibrated steel. General specifications

GOST 1133-71 Forged rod-iron and squares. Steel range

GOST 1763-68 (ISO 3887-77) Steel. Methods for determination of the depth of decarbonized layer

GOST 1778-70 (ISO 4967-79) Steel. Metallographic methods for determination of nonmetallic inclusions

GOST 2590-88 Hot-rolled rod-iron. Steel range

GOST 2591-88 Hot-rolled squares. Steel range

GOST 4405-75 Hot-rolled and forged bands of tool steel. Steel range

GOST 5639-82 Steels and alloys. Methods for exposing of grain and for determination of grain dimensions

GOST 7417-75 Calibrated rod-iron. Steel range

GOST 7565-81 (ISO 377-2-89) Cast iron, steel and alloys. Method for sampling and determination of chemical composition

GOST 7566-94 Metal products. Acceptance procedure, marking, packing, transportation and storage

GOST 8233-56 Steel. Microstructure standards

GOST 8559-75 Calibrated squares. Steel range

GOST 8560-78 Rolled hexagonal calibrated steel. Steel range

GOST 9012-59 (ISO 410-82, ISO 6506-81) Metals. Method for measurement of ball-hardness

GOST 9013-59 (ISO 6508-86) Metals. Method for measurement of Rockwell hardness

GOST 10243-75 Steel. Method for testing and estimation of macrostructure

GOST 12344-88 Alloy and high-alloy steel. Methods for determination of temper

GOST 12345-2001 Alloy and high-alloy steel. Methods for determination of sulfur content

GOST 12346-78 (ISO 439-82, ISO 4829-1-86) Alloy and high-alloy steel. Methods for determination of silicon content

GOST 12347-77 Alloy and high-alloy steel. Methods for determination of phosphorus content

GOST 12348-78 (ISO 629-82) Alloy and high-alloy steel. Methods for determination of manganese content

GOST 12349-83 Alloy and high-alloy steel. Methods for determination of tungsten content

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GOST 12350-78 Alloy and high-alloy steel. Methods for determination chromium content
GOST 12351-81 Alloy and high-alloy steel. Methods for determination of vanadium content
GOST 12352-81 Alloy and high-alloy steel. Methods for determination of nickel content
GOST 12354-81 Alloy and high-alloy steel. Methods for determination of molybdenum content
GOST 12355-78 Alloy and high-alloy steel. Methods for determination of copper content
GOST 12356-81 Alloy and high-alloy steel. Methods for determination of the titan content
GOST 12361-82 Alloy and high-alloy steel. Methods for determination niobium content
GOST 14955-77 Quality rod-iron with special surface finish. Specifications
GOST 18895-97 Steel. Method of photo-electric spectrum analysis
GOST 26877-91 Metal products. Methods for measurement of form deviations
GOST 28033-89 Steel. Method of roentgeno-fluorescent analysis
GOST 28473-90 Cast iron, steel, ferroalloys, chromium, metal manganese. General requirements for methods of analysis

3 Classifications, key parameters and dimensions

3.1 Classification

Metal products are subdivided:

- in two groups by their purpose depending on steel grade (see Appendix A):

I – for manufacturing of tools used mainly for working of metal and other materials in the cold state;

II – for manufacturing of tools used subsequently at the customer's enterprise for non-cutting shaping of metals at a temperature exceeding 300 °C;

- by the way of subsequent working of hot-rolled and forged metal products of the I and II groups in two subgroups:

а - for hot non-cutting shaping (swaging, upsetting), for cold drawing without control of structural characteristics;

б - for cold metal working (turning, planing, millings, etc.) with full volume of tests;

- the metal products are subdivided by surface quality and surface finish into the following subgroups:

the hot-rolled and forged products:

2ГП is for the *а* subgroup;

3ГП is for the *б* subgroup of the premium quality products;

4ГП is for the *б* subgroup of the regular quality products;

the calibrated products are subdivided into *Б* and *В* subgroups of products;

the products with special surface finish are subdivided into *В*, *Г*, *Д* subgroups of products.

Marking of surface finish shall be specified in the order of the customer.

3.2 Grades

3.2.1 Grades and chemical composition of steel, determined using heat analysis, shall comply with table 1.

Table 1

Steel grade	Fraction of the total mass, %							
	carbon	silicon	manganese	chromium	tungsten	vanadium	molybdenum	nickel
Group *I*								
13Х	1.25-1.40	0.10-0.40	0.15-0.45	0.40-0.70	—	—	—	—
8ХФ	0.70-0.80	0.10-0.40	0.15-0.45	0.40-0.70	—	0.15-0.30	—	—
9ХФ	0.80-0.90	0.10-0.40	0.30-0.60	0.40-0.70	—	0.15-0.30	—	—
11ХФ (11Х)	1.05-1.15	0.10-0.40	0.40-0.70	0.40-0.70	—	0.15-0.30	—	—
9ХФМ	0.80-0.90	0.10-0.40	0.30-0.60	0.40-0.70	—	0.15-0.30	0.15-0.25	—
Х	0.95-1.10	0.10-0.40	0.15-0.45	1.30-1.65	—	—	—	—
9Х1	0.80-0.95	0.25-0.45	0.15-0.45	1.40-1.70	—	—	—	—
12Х1 (120Х, ЭП430)	1.15-1.25	0.10-0.40	0.30-0.60	1.30-1.65	—	—	—	—

Continuation of table 1

Steel grade	Fraction of the total mass, %							
	carbon	silicon	manganese	chromium	tungsten	vanadium	molybdenum	nickel
6ХС	0.60-0.70	0.60-1.00	0.15-0.45	1.00-1.30	—	—	—	—
9Г2Ф	0.85-0.95	0.10-0.40	1.70-2.20	—	—	0.10-0.30	—	—
9ХВГ	0.85-0.95	0.10-0.40	0.90-1.20	0.50-0.80	0.50-0.80	—	—	—
6ХВГ	0.55-0.70	0.10-0.40	0.90-1.20	0.50-0.80	0.50-0.80	—	—	—
9ХС	0.85-0.95	1.20-1.60	0.30-0.60	0.95-1.25	—	—	—	—
В2Ф	1.05-1.22	0.10-0.40	0.15-0.45	0.20-0.40	1.60-2.00	0.15-0.30	—	—
ХГС	0.95-1.05	0.40-0.70	0.85-1.25	1.30-1.65	—	—	—	—
4ХС	0.35-0.45	1.20-1.60	0.15-0.45	1.30-1.60	—	—	—	—
ХВСГФ	0.95-1.05	0.65-1.00	0.60-0.90	0.60-1.10	0.50-0.80	0.05-0.15	—	—
ХВГ	0.90-1.05	0.10-0.40	0.80-1.10	0.90-1.20	1.20-1.60	—	—	—
6ХВ2С	0.55-0.65	0.50-0.80	0.15-0.45	1.00-1.30	2.20-2.70	—	—	—
5ХВ2СФ	0.45-0.55	0.80-1.10	0.15-0.45	0.90-1.20	1.80-2.30	0.15-0.30	—	—
6Х3МФС (ЭП788)	0.55-0.62	0.35-0.65	0.20-0.60	2.60-3.30		0.30-0.60	0.20-0.50	—
7ХГ2ВМФ	0.68-0.76	0.10-0.40	1.80-2.30	1.50-1.80	0.55-0.90	0.10-0.25	0.50-0.80	—
9Х5ВФ	0.85-1.00	0.10-0.40	0.15-0.45	4.50-5.50	0.80-1.20	0.15-0.30	—	—
8Х6НФТ (85Х6НФТ)	0.80-0.90	0.10-0.40	0.15-0.45	5.00-6.00		0.30-0.50	—	0.90-1.30. titan 0.05-0.15
6Х4М2ФС (ДИ55)	0.57-0.65	0.70-1.00	0.15-0.45	3.80-4.40		0.40-0.60	2.00-2.40	—
Х6ВФ	1.05-1.15	0.10-0.40	0.15-0.45	5.50-6.50	1.10-1.50	0.50-0.80	—	—
8Х4В2МФС2 (ЭП761)	0.80-0.90	1.70-2.00	0.20-0.50	4.50-5.10	1.80-2.30	1.10-1.40	0.80-1.10	—
11Х4В2МФ3С2 (ДИ37)	1.05-1.15	1.40-1.80	0.20-0.50	3.50-4.20	2.00-2.70	2.30-2.80	0.30-0.50	No more 0.40
6Х6В3МФС (55Х6В3СМФ, ЭП569)	0.50-0.60	0.60-0.90	0.15-0.45	5.50-6.50	2.50-3.20	0.50-0.80	0.60-0.90	—
Х12	2.00-2.20	0.10-0.40	0.15-0.45	11.50-13.00	—	—	—	—
Х12МФ	1.45-1.65	0.10-0.40	0.15-0.45	11.00-12.50	—	0.15-0.30	0.40-0.60	—
Х12Ф1	1.25-1.45	0.10-0.40	0.15-0.45	11.00-12.50	—	0.70-0.90	—	—
Х12ВМФ	2.00-2.20	0.10-0.40	0.15-0.45	11.00-12.50	0.50-0.80	0.15-0.30	0.60-0.90	—
Group *II*								
5ХНМ	0.50-0.60	0.10-0.40	0.50-0.80	0.50-0.80	—	—	0.15-0.30	1.40-1.80
5ХНВ	0.50-0.60	0.10-0.40	0.50-0.80	0.50-0.80	0.40-0.70	—	—	1.40-1.80
5ХНВС	0.50-0.60	0.60-0.90	0.30-0.60	1.30-1.60	0.40-0.70	—	—	0.80-1.20
7Х3	0.65-0.75	0.10-0.40	0.15-0.45	3.20-3.80		—	—	—
8Х3	0.75-0.85	0.10-0.40	0.15-0.45	3.20-3.80		—	—	—
4ХМФС (40ХСМФ)	0.37-0.45	0.50-0.80	0.50-0.80	1.50-1.80		0.30-0.50	0.90-1.20	—
4ХМНФС	0.35-0.45	0.70-1.00	0.15-0.45	1.25-1.55	—	0.35-0.50	0.65-0.85	1.20-1.60
3Х2МНФ	0.27-0.33	0.10-0.40	0.30-0.60	2.00-2.50	—	0.25-0.40	0.40-0.60	1.20-1.60
5Х2МНФ (ДИ32)	0.46-0.53	0.10-0.40	0.40-0.70	1.50-2.00	—	0.30-0.50	0.80-1.10	1.20-1.60
4Х3ВМФ (3И2)	0.40-0.48	0.60-0.90	0.30-0.60	2.80-3.50	0.60-1.00	0.60-0.90	0.40-0.60	—
3Х3М3Ф	0.27-0.34	0.10-0.40	0.20-0.50	2.80-3.50	—	0.40-0.60	2.50-3.00	—
4Х5МФС	0.32-0.40	0.90-1.20	0.20-0.50	4.50-5.50	—	0.30-0.50	1.20-1.50	—
4Х4ВМФС (ДИ22)	0.37-0.44	0.60-1.00	0.20-0.50	3.20-4.00	0.80-1.20	0.60-0.90	1.20-1.50	—
4Х5МФ1С (ЭП572)	0.37-0.44	0.90-1.20	0.20-0.50	4.50-5.50	—	0.80-1.10	1.20-1.50	—
4Х5В2ФС (ЭИ958)	0.35-0.45	0.80-1.20	0.15-0.45	4.50-5.50	1.60-2.20	0.60-0.90	—	—
4Х2В5МФ (ЭИ959)	0.30-0.40	0.10-0.40	0.10-0.45	2.20-3.00	4.50-5.50	0.60-0.90	0.60-0.90	—

Ending of table 1

Steel grade	Fraction of the total mass, %							
	carbon	silicon	Manganese	chromium	tungsten	vanadium	molybdenum	nickel
5Х3В3МФС (ДИ23)	0.45-0.52	0.50-0.80	0.20-0.50	2.50-3.20	3.00-3.60	1.50-1.80	0.80-1.10	Niobium 0.05-0.15
05Х12Н6Д2МФСГТ (ДИ80)	0.01-0.08	0.60-1.20	0.20-1.20	11.50-13.50	—	0.20-0.50	0.20-0.40. copper 1.40-2.20	5.50-6.50. titan 0.40-0.80

N o t e – The first figures of the designation of the steel grade specify carbon fraction of the total mass in tenth parts. It is allowed not to specify this fraction in case when it is equal to 0.1 or exceeds it. The letters specify the following elements: *Г* - manganese, *С* - silicon, *Х* - chromium, *В* - tungsten, *Ф* - vanadium, *Н* - nickel, *М* - molybdenum, *Д* - copper, *Т* - titan. The integers that follow the letters specify the average fraction of the total mass of corresponding alloying element expressed in percent. Absence of certain figures means that the fraction of the total mass of corresponding alloying element is approximately equal to 1 %. The fraction of the total mass of alloying elements may not be specified in separate cases when it does not exceed 1.8 %.

3.2.1.1 Fraction of the total mass of sulfur and phosphorus in steel shall not exceed 0.030 % (for each element).

3.2.1.2 The fractions 0.05 % of zirconium and 0.003 % of boron shall be added to the *4ХМНФС* grade steel by calculation.

The fractions of magnesium and calcium (0.03 % for each element) and 0.015 % of zirconium shall be added to the *05Х12Н6Д2МФСГТ* grade steel by calculation.

The fractions, added by calculation, may not be determined using chemical analysis.

3.2.1.3 Fraction of the total mass of residual nickel in steels of all grades not alloyed by nickel shall not exceed 0.40 %. It shall not exceed 0.60 % in the *4Х4ВМФС* grade steel.

3.2.1.4 The fraction of the total mass of residual copper in steel shall not exceed 0.30 %.

3.2.1.5 It is allowed to manufacture tungsten steels with the fraction of residual molybdenum not exceeding 0.30 % (if the fraction of the total mass of tungsten in steel does not exceed 3.00 %) and not exceeding 0.50 % (if the fraction of the total mass of tungsten in steel exceeds 3.00 %) in case when all other requirements of this Standard are observed.

3.2.1.6 The fraction of the total mass shall not exceed 0.20 % for tungsten and molybdenum (for each element), 0.15 % for vanadium and 0.03 % for titan in case when the steel is not specially alloyed with tungsten, vanadium, molybdenum and titan.

3.2.1.7 It is allowed to replace tungsten partially with molybdenum in tungsten steels: one fraction of the total mass of tungsten is equivalent to one fraction of the total mass of molybdenum.

The quantity of the replaced tungsten shall be no more than 0.1 % in steels with the fraction of the total mass of tungsten not exceeding 1.5 %. It shall be no more than 0.2 % in steels with the fraction of the total mass of tungsten not exceeding 2 %.

The sum fraction of the total mass of tungsten and molybdenum shall not exceed the specified fraction of the total mass of tungsten.

3.2.1.8 It is allowed to replace molybdenum partially with tungsten in molybdenum steels: one fraction of the total mass of molybdenum is equivalent to two fractions of the total mass of tungsten.

The quantity of the replaced molybdenum shall be no more than 0.1 % in steels with the fraction of the total mass of molybdenum not exceeding 1.2 % inclusive. It shall be no more than 0.2 % in steels with the fraction of the total mass of milybdenum not exceeding 1.2 %.

The sum fraction of the total mass of tungsten, counted to molybdenum, and molybdenum itself shall not exceed the specified fraction of the total mass of molybdenum.

The *5ХНМ* and *5Х2МНФ* grade steels make the exception. The minimum fraction of the total mass of molybdenum in the *5ХНМ* grade steel shall be equal to 0.10 %. The sum fraction of the total mass of molybdenum and tungsten, counted to molybdenum, shall be from 0.15 % to 0.30 %. The minimum fraction of the total mass of molybdenum in the *5Х2МНФ* grade steel shall be equal to 0.40 %. The sum fraction of the total mass of molybdenum and tungsten, counted to molybdenum, shall be from 0.80 % to 1.20 %. The steel shall have the *5Х2ВМНФ* marking if the fraction of the total mass of tungsten exceeds 0.20 %.

3.2.2 Deviations of chemical composition from norms of table 1 in compliance with table 2 are allowed for finished rolled steel, ingots, blooms, slabs, part blanks, forging and products of further remake.

Table 2

Name of the element	Fraction of the total mass of the element in the grade steel determined using heat analysis, %	Permissible deviation, %
Carbon	Up to 0.60 inclusive	±0.01
	Over 0.60	±0.02
Silicon	Up to 1.00 inclusive	±0.02
	Over 1.00	±0.05
Manganese	Up to 1.00 inclusive	±0.02
	Over 1.00	±0.05
Chromium	Up to 1.00 inclusive	±0.02
	From 1.00 to 4.00 inclusive	±0.05
	Over 4.00	±0.10
Tungsten	Up to 2.50 inclusive	±0.05
	Over 2.50	±0.10
Molybdenum	Up to 1.00 inclusive	±0.02
	Over 1.00	±0.05
Nickel	In compliance with table 1	±0.05
Niobium	In compliance with table 1	±0.01
Vanadium	Up to 0.60 inclusive	±0.02
	Over 0.60	±0.05
Copper	Over 1.00	±0.05
The titan	In compliance with table 1	±0.02
Sulfur	—	+0.005
Phosphorus	—	+0.005

3.3 **Steel range**

3.3.1 Metal products are: rod-iron, squares, strips and hanks.

3.3.2 Metal products shall comply with the following requirements for their shapes, dimensions and extreme deviations:

- forged rod-iron and squares shall comply with GOST 1133;
- hot-rolled rod-iron shall comply with GOST 2590;
- hot-rolled squares shall comply with GOST 2591 and other normative documentation;
- strips shall comply with GOST 4405;
- calibrated steel of *h11* and *h12* classes of accuracy shall comply with GOST 7417, GOST 8559, GOST 8560;
- steels of *h11* and *h12* classes of accuracy with special surface finish shall comply with GOST 14955.

Examples of marking:

1) Hot-rolled rod-iron bars, regular rolling accuracy (*B*), class *I* of curvature, out-of-tolerance (*НД*) length, 80 mm in diameter in compliance with GOST 2590-88, *9ХС* grade steel, subgroup *а*, group *2ГП* of surface quality:

Круг В-1-НД-80 ГОСТ 2590-88 / 9ХС-а-2ГП ГОСТ 5950-2000

2) Calibrated bar, rod-iron, class *h11* of extreme deviations, base (*МД*) length, 20 mm in diameter in compliance with GOST 7417-75, *ХВГ* grade steel, group (*В*) of surface quality in compliance with GOST 1051-73:

Круг h11-МД-20 ГОСТ 7417-75 / ХВГ-В ГОСТ 5950-2000

3) Forged strip, base (*МД*) length, 40 mm thick and 60 mm wide in compliance with GOST 4405-75, *7ХГ2ВМФ* grade steel, subgroup *б*, regular *3ГП* surface quality:

Полоса МД-40×60 ГОСТ 4405-75 / 7ХГ2ВМФ-б-3ГП ГОСТ 5950-2000

4 General technical requirements

4.1 Characteristics of the base modification

4.1.1 Delivery conditions

4.1.1.1 Metal products shall be manufactured in compliance with requirements of this Standard using the production schedules in accordance with the established procedure.

4.1.1.2 Metal products shall be thermally treated (using annealing or high-temperature tempering). Metal products made of *11ХФ, 13Х, 9Х1, Х, 12Х1, 9ХС, В2Ф, ХГС, 9ХВГ, ХВГ, ХВСГФ* grade steel and intended for manufacturing of cutters shall be annealed (*ОТ*).

Purpose of the metal products shall be specified in the order of the customer.

4.1.1.3 Ends of bars and strips shall be cut off or chopped off without burrs and chips. The length of collapsed ends shall not exceed:

- 1.5 diameters (thicknesses) for metal products up to 10 mm in diameter (thick);
- 40 mm for metal products that are from 10 to 60 mm in diameter (thick);
- 60 mm for metal products that are over 60 mm in diameter (thick).

4.1.2 Properties

4.1.2.1 Hardness of the metal products made of all the steel grades intended for hot non-cutting shaping and for cold drawing (subgroup *а*) except for metal products made of the *05Х12Н6Д2МФСГТ* grade steel shall not exceed *НВ* 255 (the impression diameter shall be no less than 3.8 mm).

Hardness of the metal products made of the *05Х12Н6Д2МФСГТ* grade steel shall not exceed *НВ* 293 (the impression diameter shall be no less than 3.5 mm).

Hardness of the metal products determined under delivery conditions and intended for cold machining (subgroup *б*) shall comply with the values specified in table 3.

Table 3

Steel grade	Hardness in *НВ* units, no more than	Impression diameter, mm, no less than	Steel grade	Hardness in *НВ* units, no more than	Impression diameter, mm, no less than
13Х	248	3.85	Х6ВФ	241	3.9
8ХФ	241	3.9	8Х4В2МФС2	255	3.8
9ХФ	241	3.9	11Х4В2МФ3С2	255	3.8
ПХФ (ПХ)	229	4.0	6Х6В3МФС	255	3.8
Х	229	4.0	Х12	255	3.8
9Х1	229	4.0	Х12МФ	255	3.8
12Х1	241	3.9	Х12Ф1	255	3.8
6ХС	229	4.0	Х12ВМФ	255	3.8
9Г2Ф	229	4.0	5ХНМ	241	3.9
9ХВГ	241	3.9	5ХНВ	255	3.8
6ХВГ	217	4.1	5ХНВС	255	3.8
9ХС	241	3.9	7Х3	229	4.0
В2Ф	229	4.0	8Х3	241	3.9
ХГС	241	3.9	4ХМФС	241	3.9
4ХС	217	4.1	5Х2МНФ	255	3.8
ХВСГФ	241	3.9	4Х3ВМФ	241	3.9
ХВГ	255	3.8	3Х3М3Ф	229	4.0
6ХВ2С	255	3.8	4Х5МФС	241	3.9
5ХВ2СФ	229	4.0	4Х4ВМФС	241	3.9
6Х3МФС	241	3.9	4Х5МФ1С	241	3.9
7ХГ2ВМФ	255	3.8	4Х5В2ФС	241	3.9
9Х5ВФ	241	3.9	4Х2В5МФ	241	3.9
8Х6НФТ	241	3.9	5Х3В3МФС	241	3.9
6Х4М2ФС	255	3.8	05Х12Н6Д2МФСГТ	293	3.5

Hardness values of the metal products made of the *05Х12Н6Д2МФСГТ* grade steel (subgroups *а*, *б*) shall not be rejected but they shall be registered in a quality document.

4.1.2.2 Hardness of samples of the metal products subjected to hardening and self-tempering hardening shall comply with table 4.

Table 4

Steel grade	Hardening temperature, °С, hardening medium	Tempering temperature, °С	Hardness in $HRC_э$ (*HRC*) units, no less than
13Х	790-810, water	180	61 (60)
8ХФ	820-840, oil	180	58 (57)
11ХФ	810-830, oil	—	63 (62)
Х	830-850, oil	180	60 (59)

Ending of table 4

Steel grade	Hardening temperature, °C, hardening medium	Tempering temperature, °C	Hardness in $HRC_э$ (*HRC*) units, no less than
9Х1	820-850, oil	—	63 (62)
12Х1	850-870, oil	—	63 (62)
9Г2Ф	780-800, oil	180	60 (59)
9ХВГ	820-840, oil	—	63 (62)
9ХС	840-860, oil	—	63 (62)
В2Ф	820-840, water	180	60 (59)
ХГС	820-860, oil	—	63 (62)
ХВСГФ	840-860, oil	—	63 (62)
ХВГ	820-840, oil	180	61 (60)
5ХВ2СФ	900-920, oil	180	56 (55)
Х12	960-980, oil	180	62 (61)
Х12МФ	960-980, oil	180	61 (60)
Х12ВМФ	1010-1030, oil	180	61 (60)
5ХНМ	840-860, oil	550	36 (35)
5Х2МНФ	960-980, oil	550	45 (44)
3Х3М3Ф	1030-1050, oil	550	46 (45)
4Х5МФС	1010-1030, oil	550	48 (47)
4Х4ВМФС	1050-1070, oil	550	50 (49)
4Х5МФ1С	1020-1040, oil	550	48 (47)
5Х3В3МФС	1120-1140, oil	550	50 (49)

N o t e s

1 Deviations from the tempering temperatures specified in the table shall not exceed ±10 °C.

2 Hardness values of the hardened samples of steels of other grades are specified in Appendix B.

The hardness obtained by hardening and tempering are specified in Appendix B depending on tempering temperature.

4.1.3 Surface condition of the metal products

4.1.3.1 Depth of decarbonized layer (ferrite + transition zone) on each side of the hot-rolled and forged metal products shall not exceed (counting from the actual dimension):

- 0.35 mm for the metal products from 4 to 8 mm in diameter (thick);
- 0.4 mm for the metal products from 8 to 15 mm in diameter (thick);
- 0.5 mm for the metal products from 15 to 30 mm in diameter (thick);
- 0.7 mm for the metal products from 30 to 50 mm in diameter (thick);
- 1.0 mm for the metal products from 50 to 70 mm in diameter (thick);
- 1.3 mm for the metal products from 70 to 100 mm in diameter (thick).

Depth of decarbonized layer on each side of the calibrated metal products shall not exceed:

- 1.5 % of the actual diameter (thickness) for the metal products made of steel containing no more than 0.5 % of silicon or no more than 1.0 % of molybdenum;
- 2.0 % of the actual diameter (thickness) for the metal products made of steel containing more than 0.5 % of silicon or more than 1.0 % of molybdenum.

There shall be no decarbonized layer in the bars with special surface finish.

4.1.3.2 There shall be no cracks, rolled-ins, blisters, rolled (unset) bubbles and contaminations.

The defects shall be removed using flat cutting or chipping. The chipping width shall be no less than the fivefold chipping depth.

The chipping depth shall not exceed (counting from the actual dimension of the metal product):

- half of the sum of extreme deviations from the bar dimension in case when its diameter (thickness) is less than 80 mm;
- the sums of extreme deviations from the bar dimension in case when its diameter (thickness) is from 80 to 140 mm;
- 5 % from the nominal bar dimension (diameter, thickness) in case when its cross section is more than 140 mm;
- the sums of extreme deviations of the strip dimension.

Chipping shall not be made more than twice in one cross section.

Separate small scratches, impressions, cratering and other defects of mechanical origin are allowed without chipping in case when their depth does not exceed half of the sum of extreme deviations of the dimension.

Separate small blisters, rolled-in contaminations and bubbles, defects of mechanical origin (impressions, scratches, file marks, cratering, etc.) are allowed on the surface of hot-rolled hanks in case when their depth does not exceed 0.25 part of the sum of extreme deviations counting from the actual dimension.

4.1.3.3 The local defects are allowed on the surface of the metal products from *3ГП* and *4ГП* quality groups in case when their depth does not exceed:

- half of the sum of extreme deviations from the dimensions that are less than 80 mm in diameter (thick);
- the sum of extreme deviations from the dimensions that are no less than 80 mm in diameter (thick).

The depth of defects shall be counted from the actual dimensions of the metal products from the *3ГП* quality group. They shall be counted from the nominal dimensions in case of the *4ГП* quality group.

4.1.3.4 The surface of the calibrated metal products shall comply with the requirements of the group *В* GOST 1051. The surface of the calibrated rod-iron products shall comply with the requirements of the group *Б* GOST 1051. It shall comply with the requirements of the groups *В, Г, Д* GOST 14955 in case of special surface finish.

4.1.4 Structural characteristics

4.1.4.1 There shall be no shrinkage friability, bubbles, stratifications, cracks, inclusions, blisters and flakes in the macrostructure of the metal products in case of their check using etched templates.

The macrostructure defects are allowed in case when they are specified in table 5.

Table 5

Allowed macrostructure defects	Defect number, no more than
Shrinkage segregation	1
Segregation square	1
Central porosity	2
Ghost	2
Pointwise heterogeneity	3
Raised etchability of the core zone (for metal intended for continuous casting)	2

4.1.4.2 The microstructure of the hot-rolled and forged metal products of the *б* subgroup (calibrated ones and the ones with special surface finish) made of *11ХФ, 13Х, 9Х1, Х, 12Х1, 9ХС, В2Ф, ХГС, 9ХВГ, ХВСГФ, ХВГ, 8ХФ, 9Г2Ф* grade steel and less than 60 mm in diameter (thick) shall comply with:

- - the requirements for divorced pearlite with the defect number from 1 to 6 (see Appendix D);
- - the requirements for the remains of carbide network:
  - with the defect number no more than 3 for the *11ХФ, 9Х1, Х, 9ХС, В2Ф, ХГС, 9ХВГ, ХВСГФ* grade steel;
  - with the defect number no more than 4 for the *12Х1* grade steel;
  - with the defect number equal to 3 or 4 for the *13Х* and *ХВГ* grade steel (see Appendix G).

The defect number of carbide network shall be specified in the order of the customer for the metal products made of the *13Х* and *ХВГ* grade steel.

4.1.4.3 Carbide heterogeneity of the *9Х5ВФ, 8Х6НФТ, 8Х4В2МФС2, Х6ВФ, Х12*, *Х12ВМФ, Х12МФ, Х12Ф1, 6Х6В3МФС, 11Х4В2МФ3С2, 6Х4М2ФС* grade steel shall not exceed the norms specified in table 6 depending on dimensions of the metal products (see Appendices E, F).

Table 6

Diameter (thickness) of the metal product, mm	Maximum permissible norm of carbide heterogeneity, heterogeneity number, steel grade	
	9Х5ВФ, 8Х6НФТ, 8Х4В2МФС2, Х6ВФ, 6Х6В3МФС, 6Х4М2ФС, 11Х4В2МФ3С2	Х12, Х12МФ, Х12Ф1, Х12ВМФ
Up to 40	3	4
From 40 to 60 inclusive	4	5
From 60 to 80 inclusive	5	6
From 80 to 100 inclusive	6	7

4.1.4.4 Dimension of austenite grain of the metal products of the *б* subgroup shall comply with table 7 depending on the product dimensions.

Table 7

Purpose group	Steel grade	Diameter (thickness) of the metal product, mm	Dimension of austenite grain of the hardened samples, no larger than the grain number	
			in compliance with GOST 5639	Using fracture Scale (Appendix I)
I	6ХС, 6ХВГ, 4ХС, 6ХВ2С, 5ХВ2СФ, 6Х3МФС, 7ХГ2ВМФ, 6Х4М2ФС, Х6ВФ, 8Х4В2МФС2, 11Х4В2МФ3С2, 6Х6В3МФС, Х12, Х12МФ, Х12Ф1, Х12ВМФ	Up to 80 inclusive From 80 to 140 inclusive	9 8	4 3
II	All the steel grades	Up to 80 inclusive From 80 to 140 inclusive	8 6	3 2

4.1.4.5 The norms of structural characteristics (pearlite, carbide network, carbide heterogeneity, dimension of austenite grain) established for strips shall comply with the norms established for square profile bars with isometric cross-section area.

4.2 The characteristics established by the agreement between the customer and the manufacturer

4.2.1 The steel is manufactured using the method of electroslag remelting with the fraction of the total mass of sulfur no more than 0.015 %.

4.2.2 The fraction of the total mass of manganese in the *Х12, Х12ВМФ, Х12МФ, Х12Ф1* grade steel (determined by heat analysis) is from 0.15 % to 0.60 %.

4.2.3 The metal products are manufactured using the *Х12ВМФ* grade steel without tungsten and the *6Х3МФС* grade steel without molybdenum. In this case the corresponding steel grades are marked *Х12М1Ф* and *6Х3ФС* accordingly.

4.2.4 The limits of the fraction of the total mass of separate elements are narrowed in comparison with table 1. The norms are stipulated in the order of the customer.

4.2.5 The fractions of the total mass (determined by heat analysis) do not exceed 0.020 % for sulfur and phosphorus and 0.20 % for nickel in the *8ХФ, 9ХФ, В2Ф* grade steel.

4.2.6 The metal products are manufactured using the *8ХФ, 9ХФ, 11ХФ* grade steel without vanadium. In this case the corresponding grades are marked *8Х, 9Х, 11Х* accordingly.

4.2.7 The fractions of the total mass of carbon and chromium in the *9Х1* grade steel (determined by heat analysis) are from 0.78 % to 0.92 % and from 1.4 % to 1.9 % accordingly.

4.2.8 The depth of decarbonized layer of the metal products annealed in the furnace without protective atmosphere. The norms are established in compliance with the agreement.

4.2.9 Hardness of the metal products made of the *8ХФ, 9ХФ, 6Х3МФС* grade steel after annealing or high-temperature tempering does not exceed *НВ* 217 (the impression diameter is no less than 4.1 mm).

4.2.10 Divorced pearlite and carbide network of the metal products over 60 mm in diameter (thick) is under control for the steel grades specified in clause 4.1.4.2 of this Standard. The norms are established in compliance with the agreement.

4.2.11 The norms of divorced pearlite comply with the defect number from 1 up to 7 for the metal products up to 60 mm in diameter (thick) and made of the *9ХС* grade steel.

4.2.12 Carbide heterogeneity of the *11ХФ, 13Х, 9Х1, Х, 12Х1, 9ХС, В2Ф, ХГС, 9ХВГ, ХВГ, ХВСГФ* grade steels is under control using the *6А* Scale in compliance with GOST 8233. The norms are established in compliance with the agreement.

4.2.13 Carbide heterogeneity number of the *9Х5ВФ, 11Х4В2МФ3С2, 6Х4М2ФС* grade steels is lower by 1 number than the normative value specified in table 6.

4.2.14 Nonmetallic inclusions of all the steel grades are under control. The permissible norms for contamination of steel with nonmetallic inclusions shall comply with table 8 or shall be established in compliance with the agreement between the parties.

Table 8

Method of smelting	Diameter (thickness) of the metal product, mm	Nonmetallic inclusions, contamination number, no more than			
		Oxides	Sulfides	Nitrides	Silicates
Open smelting	Up to 40 inclusive Over 40	3 4	2.5 3	3 3.5	3 4

Ending of table 8

Method of smelting	Diameter (thickness) of the metal product, mm	Nonmetallic inclusions, contamination number, no more than			
		Oxides	Sulfides	Nitrides	Silicates
Electroslag remelting	Up to 40 inclusive Over 40	1.5 2.5	1 2	1 2	1.5 2.5

4.2.15 Hardness of hardened and tempered samples made of steel grades not specified in table 4. The norms are established in compliance with the agreement.

4.3 Marking, packing

4.3.1 General marking rules shall be in compliance with GOST 7566. The metal products manufactured using the method of electroslag remelting shall be marked additonally by Russian letter *Ш*. It is inserted at the end of the grade marking after dash, for example *3Х3М3Ф-Ш*.

Bars over 50 mm in diameter (thick) shall be subjected to 100 % marking.

4.3.2 Packing of the hot-rolled and forged metal products shall be carried out in compliance with the requirements of GOST 7566.

Packing of the metal products with special surface finish shall be in compliance with GOST 14955. Packing of the calibrated metal products shall be in compliance with GOST 1051.

5 Acceptance procedure

5.1 The metal products are accepted by batches consisting of bars, strips or hanks of the same heat, the same subgroup, the same dimension, the same surface quality and the same mode of thermal treatment.

Each batch of the metal products shall be accompanied by the quality certificate in compliance with requirements of GOST 7566.

5.2 One sample of the heat shall be selected to check its chemical composition. One bar, one strip or one hank is selected from each batch of bars, strips or hanks.

5.3 The 10 % amount of bars, strips or hanks shall be selected from each batch to check the dimensions.

5.4 The following samples shall be selected for hardness check in the state of delivery:

- two bars with mass over 1 ton but no less than six samples shall be selected from the batch of bars up to 30 mm in diameter (thick);
- the 5 % amount of bars from the batch but no less than five samples shall be selected from the batch of bars more than 30 mm in diameter (thick);
- two strips or two hanks with mass over 1 ton but no less than five samples shall be selected from the batch of strips and hanks.

5.5 One bar, one strip or one hank from the batch but no less than two samples from the heat shall be selected for hardness check after hardening or after hardening with tempering.

5.6 Surface quality shall be checked for all bars, strips and hanks of the batch.

5.7 Two bars, two strips or two hanks shall be selected from the batch to check the depth of decarbonized layer.

5.8 Two bars, two strips or two hanks shall be selected from the batch for **macro**structure check.

5.9 Two bars, two strips or two hanks shall be selected from the batch for **micro**structure check (divorced pearlite, carbide network, carbide heterogeneity, dimension of austenite grain).

5.10 Two bars, two strips or two hanks but no less than six samples shall be selected from the batch to check nonmetallic inclusions.

5.11 Retest shall be carried out in compliance with GOST 7566 for at least one characteristic (except for dimensions and flakes) in case of unsatisfactory test results.

The batch shall not be accepted in case when flakes are discovered. The batch shall be subjected to 100 % rejection in case of dimension mismatch.

5.12 Macrostructure, carbide heterogeneity, dimension of austenite grain, proper hardness of the metal products up to 40 mm in diameter (thick) shall be provided by the manufacturer. The specified characteristics shall not be checked, they shall be warranted.

6 Check methods

6.1 The steel sampling for chemical composition check shall be in compliance with GOST 7565. The steel sampling for chemical analysis shall be in compliance with GOST from 12344 to 12352, GOST from 12354 to GOST 12356, GOST 12361, GOST 18895, GOST 28033 and GOST 28473. It is allowed to use other methods that provide necessary accuracy.

6.2 Dimensions and deviations of the shape of the hot-rolled, forged metal products shall be checked using universal sizing tools or patterns. The calibrated metal products and the metal products with special surface finish shall be checked using micrometers and measuring brackets in compliance with GOST 26877.

6.3 One sample shall be cut off from each selected metal product to check it in compliance with clauses 5.4, 5.5 and from 5.7 to 5.10 of this Standard.

6.4 Hardness of the annealed or high-temperature tempered metal products shall be checked in compliance with GOST 9012 after removal of decarbonized layer.

Test shall be carried out along the bars, strips or hanks lengthwise no less than 100 mm away from the ends of the sample.

There shall be no less than three impressions. Each measured hardness value shall comply with the values specified in table 3.

6.5 Hardness check of hardened or hardened-and-tempered samples shall be checked in compliance with GOST 9013. The samples shall be hardened or hardened and tempered using optimum temperature values specified in table 4.

The number of measurements shall be no less than three. The first measurement shall not be taken into account.

The shape and dimensions of the samples shall be the same as the ones taken for the check of dimension of austenite grain.

6.6 Depth of decarbonized layer of the metal products shall be determined in compliance with GOST 1763. It is allowed to check the rolled steel with special surface finish using the method of thermo-electromotive force.

The check of the depth of decarbonized layer shall be carried out using the *M*-method in case of disagreements between the customer and the manufacturer.

N o t e . Depth of decarbonized layer of strips shall be measured along their wide side.

6.7 Surface quality of the metal products shall be checked without magnifying devices. Conditioning of the surfaces (by circles or sine-wise) shall be carried out in necessity.

6.8 Macrostructure of the metal products shall be checked using etched templates without magnifying devices in compliance with GOST 10243.

It is allowed to extend the results of the macrostructure check of the metal products with large profiles to the metal products with small profiles of the same heat. The raised etchability shall be estimated using the Scale intended for estimation of shrinkage segregation.

It is allowed to reforge the samples into circles or squares from 90 to 140 mm in diameter (thick) in case when the bars and strips are over 140 mm in diameter (thick).

The floc check may be carried out using the delivered profile.

It is allowed to carry out the floc check using part blanks.

6.9 Microstructure of the metal products shall be checked using:

- Scale No. 1 for pearlite in compliance with Appendices D and J;
- Scale No. 4 for carbide network in compliance with Appendices G and J.

6.10 Carbide heterogeneity of:

- the *Х12, Х12ВМФ, Х12МФ, Х12Ф1* grade steel shall be estimated using the Scale No. 2 in compliance with Appendices E and J;
- the *9Х5ВФ, 8Х6НФТ, Х6ВФ, 6Х6В3МФС, 6Х4М2ФС*, *11Х4В2МФ3С2, 8Х4В2МФС2* grade steel shall be estimated using the Scale No. 3 in compliance with Appendices F and J.

6.11 Dimension of austenite grain may be checked using microstructure or fracture.

The sample may be incised from one or from both sides and then broken to obtain its fracture.

The check of dimension of austenite grain of the fracture shall be carried by its visual inspection without magnifying devices by comparison of this sample with standards of the Scale No. 5 specified in Appendix I. The shape and dimensions of the samples shall comply with the requirements of GOST 10243.

Dimension of austenite grain in microstructure shall be determined using the hardened samples selected from the delivered batch. The sampling procedure, the shape and dimensions of samples intended for the check of dimension of austenite grain in microstructure are specified in Appendix J.

Austenite grain is exposed using method of etching of grain boundaries. The check of dimension of austenite grain shall be carried out in compliance with GOST 5639.

6.12 Check of nonmetallic inclusions is carried out in compliance with GOST 1778 using longitudinal sections by methods *Ш1* or *Ш4* (by comparison with reference Scales). The check method shall be chosen in accordance with the agreement with the customer.

6.13 Statistical and non-destructive check methods may be applied in compliance with normative documentation. The check methods specified by this Standard may be used in case of disagreements.

7 Transportation and storage

7.1 Transportation and storage of the metal products shall comply with the requirements of GOST 7566.

7.2 The calibrated metal products and the metal products with special surface finish shall be stored in the closed storage rooms.

8 Manufacturer's guarantees

The manufacturer shall guarantee compliance of the metal products with the requirements of this Standard from the moment of their delivery in case when all conditions of transportation and storage are observed.

APPENDIX A
(Reference)

General purpose of tool alloy steels

General purpose of tool alloy steels of different grades is specified in table A.1.

Table A.1

Steel grade	General purpose
	Group I
13Х	For shaving knifes and blades, sharp surgical tools, scrapers, gravers
8ХФ	For stamps of cold operation; knifes for cold cutting of metals; corner-cutting dies and punches for cold cutting of burrs; center-punch tools
9ХФ	For frame-saws, band-saws, ring-saws, shaving-saws; stamps of cold operation; knifes of cold cutting of metals; corner-cutting dies and punches for cold cutting of burrs; center-punch tools
11ХФ	For taps and other cutting tools up to 30 mm in diameter. It shall be forged with sequential cooling using hot mediums
Х	For chisels used for notching of files; very hard cams of eccentrics and pins; smooth cylindrical gages and gage rings; lathe, planer and slotting tools in gaging and repair shops
9Х1	For rollers of cold-rolling, rollers of skin-rolling, stamps, punches; cold-upsetting dies and punches; woodworking tools
12Х1	For sizing tools (Johansson blocks, gages, stencils)
6ХС	For pneumatic chisels and stamps with small dimensions intended for cold punching; chipping knifes
9Г2Ф	For cutting and stamping tools (billets, taps, knifes for scissors, sizing tools, stamps for pressing rubber and plastic products)
9ХВГ	For thread gages, templates with complicated shape, complicated high-accuracy stamps for cold operation. These products shall not be subjected to significant three-dimensional deforming and hogging
6ХВГ	For punches with complicated shape intended mainly for cold piercing of shaped holes in sheets and strips; small stamps for hot stamping mainly to provide minimum deformations during hardening
9ХС	For drills, reamers, taps, dies, combs, mills, machine stamps, stamps for cold operation
В2Ф	For cutter blades and band-saws intended for cutting metals

Continuation of table A.1

Steel grade	General purpose
ХГС	For rollers of cold-rolling, cold-upsetting dies and punches, punching dies with small dimensions (up to 70 mm in diameter (thick)). The *ХГС* grade steel may not replace the *ХВГ, 9ХС, ХВСГФ* grade steels during manufacturing of tools
4ХС	For chisels, sets, scissors for cold and hot cutting of metal; stamps for hot drawing
ХВСГФ	For circle billets, reamers and other tools
ХВГ	For sizing and cutting tools in case when raised hogging during hardening is inadmissible; thread gages, broaches, long taps, long reamers, billets and other special tools, cold-upsetting dies and punches, production tools
6ХВ2С, 5ХВ2СФ	For knifes intended for cold cutting of metals, for thread-rolling dies, punches and breakdown dies of cold operation; woodworking tools of long-time operation
6Х3МФС	For punches operating under increased dynamic loads; for cold-upsetting stamps, stamps; dies and some benchwork-and-assembling tools (instead of *7Х3* and *6ХВ2С* steel grades)
7ХГ2ВМФ	For stamps of three-dimension cold deforming and for blanking tools with complicated configuration. These tools may be used for non-ferrous alloys and low-strength structural steels
9Х5ВФ, 8Х6НФТ	For knifes intended for wood milling, shaving saws and others woodworking tools of the same type (for example, milling cutters)
6Х4М2ФС	For blanking and upsetting tools (stamps, punches, pneumatic chisels, etc.), for rolling tools
Х6ВФ	For thread-rolling tools (rollers and billets), manual cutter blades, shaving blades, dies, punches, gear-rolling and other tools intended for cold deforming, for wood-cutting milling tool
8Х4В2МФС2	For dies and punches of stamps intended for cold three-dimensional deforming, that stand the pressure up to 2300 MPa during operation, thread-rolling tools
11Х4В2МФ3С2	For blanking stamps, intended for the *Э412* and *Э413* cold-rolled electrical steels covered with *Карлит*-type coating; punches and dies of cold-blanking automatic machines, punches and eliminators for cold extrusion that operate under specific pressure up to 2000 MPa in conditions of extreme wear and heating of working surfaces up to 400 °С; for spline-rolling and thread-rolling tools
6Х6В3МФС	For thread-rolling rollers, gear-rolling tools, spline-rolling tools, corner-cutting dies, punches and other tools intended for cold plastic deforming of metals with increased hardness; knifes tube-cutting machines, knifes of guillotine scissors intended for cutting of high-strength steels and alloys; for chopping knifes used in woodworking industry; rock-cutters and other similar tools
Х12, Х12ВМФ	For cold stamps with high resistance to abrasion (mainly with the working part of roundish shape), that shall not be exposed to strong impacts and pushes; for draw-plates and dies, eyelets intended for calibration of bar-type metal tools used for thread-rolling, bending dies and forming stamps, for complicated sections of body stamps that shall not be subjected to significant three-dimensional deforming and hogging; dies and punches of blanking and piercing stamps; for punching of active parts of electric machines and electromagnetic systems of electric devices
Х12МФ, Х12Ф1	The same as for the *Х12* grade steel in cases when high viscosity is required; for forming rollers of complicated shape; sections of body stamps with complicated shape; complicated piercing dies used for shaping of sheet metal, reference cog-wheels, rolling billets, dies and punches of blanking, piercing stamps (including compound and sequence stamps) with complicated shape of working parts; for punching of active parts of electric machines

Ending of table A.1

Steel grade	General purpose
	Group II
5ХНМ	For hammer dies of steam-air and pneumatic hammers with mass of falling parts exceeding 3 tons; for press tools and stamps of machine high-speed punching and hot deforming of light non-metallic alloys; for die blocks used as inserts of horizontal machines
5ХНВ, 5ХНВС	For hammer dies of steam-air and pneumatic hammers with mass of falling parts up to 3 tons
7Х3, 8Х3	For tools (punches, dies) of hot blanking of fasteners and part blanks made of carbon steel and low-alloyed structural steel and used in upsetting machines; components of stamps (dies, punches, eliminators) intended for hot pressing and extrusion of these materials by crank presses during short-run manufacture; bending dies, trimming dies and dinking dies
4ХМФС	For hammer dies of steam-air and pneumatic hammers with mass of falling parts no more 3 tons, intended for deforming of alloy structural and stainless steels (instead of the less heat-resistant *5ХНМ, 5ХНВ* grade steels); for tools intended for pressing aluminium alloys
5Х2МНФ	For large-size one-piece stamps (their square side or diameter shall not exceed 600 mm) intended for forging of structural steels and heat-resistant alloys using hammers and crank presses (instead of the less heat-resistant *5ХНМ, 4ХМФС* grade steels); the tools (clamping and forming inserts, type-setting and forming punches) intended for upsetting of structural steels and heat-resistant alloys used in upsetting machines (*ГКМ*); hot-cutting knives
4Х3ВМФ	For small hammer stamps, hammer and press inserts (from 300 to 400 mm in diameter (thick)), for tools of upsetting machines intended for hot deforming of structural steels and heat-resistant steels; for tools of high-speed machine punching of structural steels
3Х3М3Ф	For tools (mostly small tools) intended for hot deforming using crank presses and upsetting machines subjected to intensive cooling during operation; die moulds for die casting of copper alloys
4Х5МФС	For small hammer stamps; for large (more than 200 mm in diameter (thick)) hammer and press inserts intended for hot deforming of structural steels and non-ferrous alloys under condition of large-Scale mass production
4Х4ВМФС	For tools of high-speed machine punching and upsetting using upsetting machines; for inserts of stamps intended for hot deforming of alloyed structural steels and heat-resistant alloys intended for hammers and crank presses (instead of less heat-resistant *4Х5В2ФС, 4Х5МФ1С, 4Х3ВМФ* grade steels); die moulds intended for die casting of copper alloys
4Х5МФ1С, 4Х5В2ФС	For die moulds intended for die casting of zinc, aluminium and magnesion alloys; for hammer and press inserts (from 200 to 250 mm in diameter(thick)) intended for hot deforming of structural steels; tools for upsetting part blanks made of alloyed structural and heat-resistant materials using upsetting machines
4Х2В5МФ	For heavy-loaded press tools (small inserts finishing die impression, small inserted signs, dies and punches for extrusion, etc.) intended for hot deforming of alloyed structural steels and heat-resistant alloys
5Х3В3МФС	For heavy-loaded press tools (piercing and forming punches, dies, etc.); tools for upsetting using upsetting machines and inserts of high-load stamps, for hot three-dimension deforming of structural steels and heat-resistant metals and alloys (instead of the less heat-resistant *3Х2В8Ф, 4Х2В5МФ* grade steels). The *5Х3В3МФС* grade steel has the highest hardenability and heat stability.
05Х12Н6Д2МФСГТ	For tools of forming elements of die moulds intended for moulding of general mechanical rubber goods and plastic products

APPENDIX B
(Reference)

Hardness obtained by hardening of tool alloy steel

Hardness of samples hardened from optimum temperatures and obtained for various grades of tool alloy steel is specified in table B.1.

Table B.1

Steel grade	Temperature, °C, Hardening medium	Hardness in $HRC_э$ (*HRC*) units, no less than
13Х	780-810, water	65 (64)
8ХФ	800-820, water	59 (58)
	830-860, oil	59 (58)
	810-830, water	59 (58)
9ХФ	850-880, oil	61 (60)
	820-840, water	61 (60)
Х	840-860, oil	63 (62)
6ХС	840-860, oil	57 (56)
9Г2Ф	780-800, oil	61 (60)
6ХВГ	850-900, oil	58 (57)
В2Ф	800-850, water	63 (62)
4ХС	880-900, oil	48 (47)
ХВГ	830-850, oil	63 (62)
6ХВ2С	860-900, oil	58 (57)
5ХВ2СФ	860-900, oil	56 (55)
6Х3МФС	980-1020, oil	57 (56)
7ХГ2ВМФ	840-880, air	59 (58)
9Х5ВФ	950-1000, oil	59 (58)
8Х6НФТ	950-1000, oil	59 (58)
6Х4М2ФС	1050-1070, oil	60 (59)
Х6ВФ	980-1000, oil	62 (61)
8Х4В2МФС2	1060-1090, oil	61 (60)
11Х4В2МФ3С2	1000-1030, oil	63 (62)
6Х6В3МФС	1055-1075, oil	61 (60)
Х12	950-1000, oil	61 (60)
Х12МФ	950-1000, oil	61 (60)
Х12Ф1	1050-1100, oil	61 (60)
Х12ВМФ	1020-1040, oil	61 (60)
5ХНМ	830-860, oil	57 (56)
5ХНВ	840-860, oil	57 (56)
5ХНВС	860-880, oil	57 (56)
7Х3	850-880, oil	55 (54)
8Х3	850-880, oil	56 (55)
4ХМФС	920-930, oil	56 (55)
5Х2МНФ	960-980, oil	57 (56)
4Х3ВМФ	1040-1060, oil	53 (52)
3Х3М3Ф	1030-1050, oil	48 (47)
4Х5МФС	1000-1020, oil	51 (50)
4Х4ВМФС	1050-1070, oil	56 (55)
4Х5МФ1С	1020-1040, oil	51 (50)
4Х5В2ФС	1030-1050, oil or air	51 (50)
4Х2В5МФ	1060-1080, oil	51 (50)
5Х3В3МФС	1120-1140, oil	54 (53)
05Х12Н6Д2МФСГТ	990-1020, oil or air	28 (27)

N o t e . The *05Х12Н6Д2МФСГТ* grade steel is the maraging one. High hardness of the metal products made of this steel is provided by its ageing for 4 hours at a temperature from 480 to 500 °C.

APPENDIX C
(Reference)

Rockwell hardness (*HRC*) versus tempering temperature curves

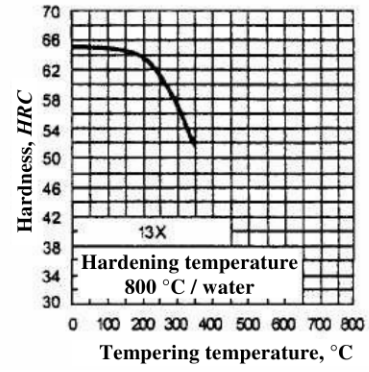


Fig. C.1

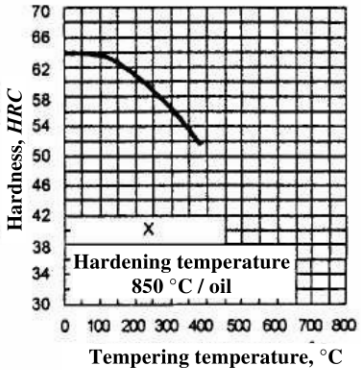


Fig. C.2

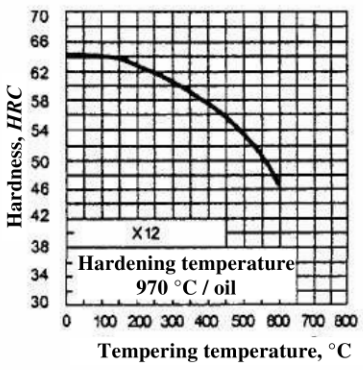


Fig. C.3

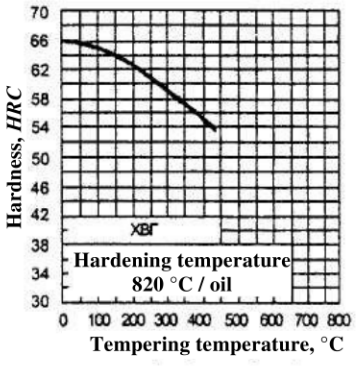


Fig. C.4

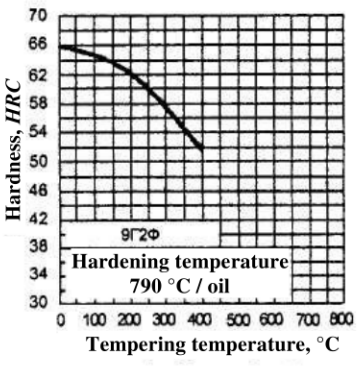


Fig. C.5

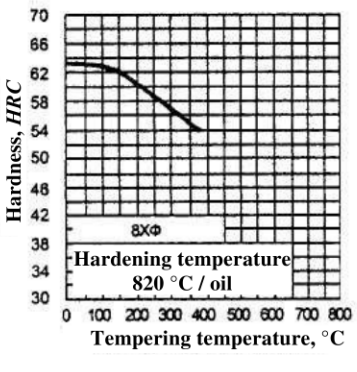


Fig. C.6

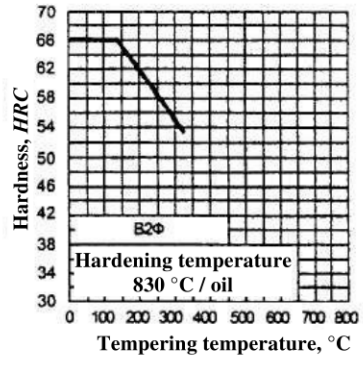


Fig. C.7

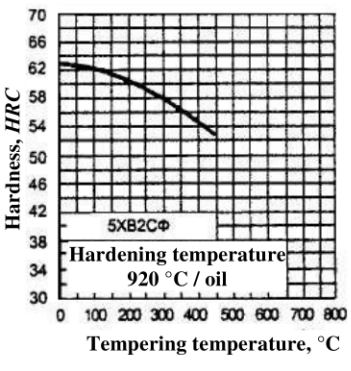


Fig. C.8

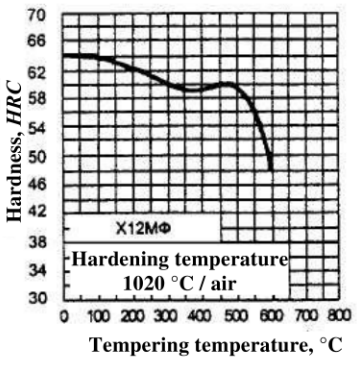


Fig. C.9

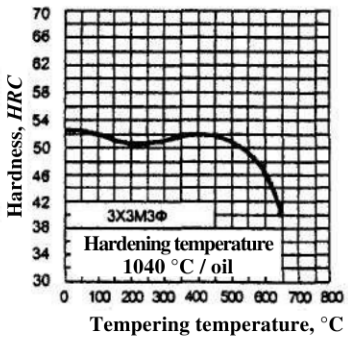


Fig. C.10

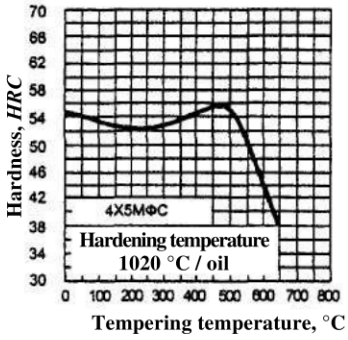


Fig. C.11

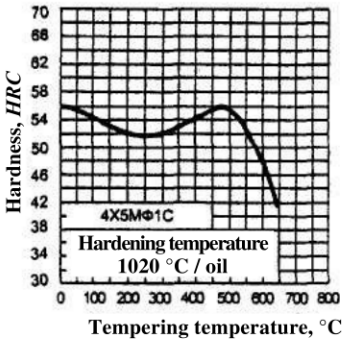


Fig. C.12

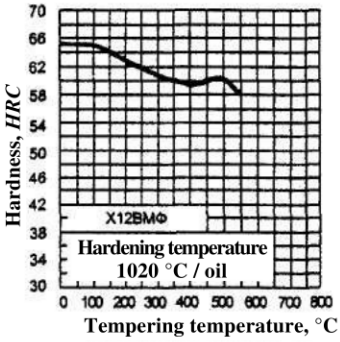


Fig. C.13

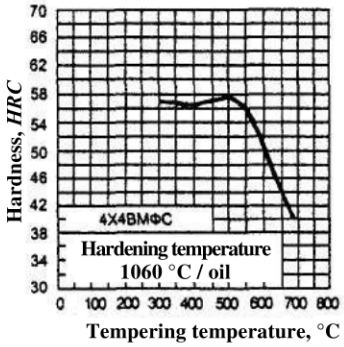


Fig. C.14

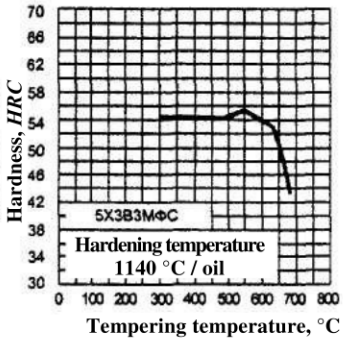


Fig. C.15

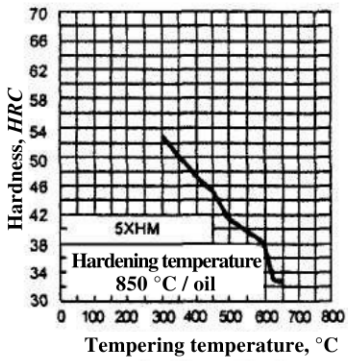


Fig. C.16

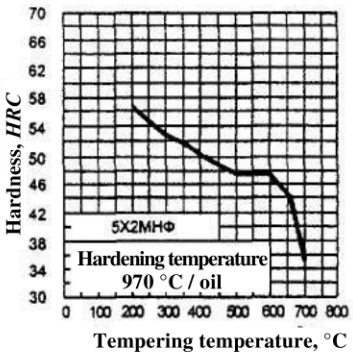


Fig. C.17

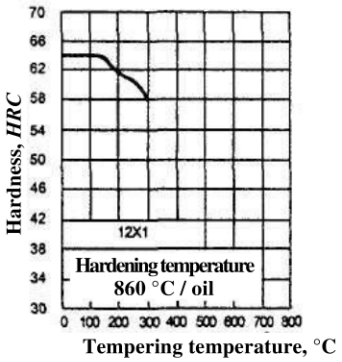


Fig. C.18

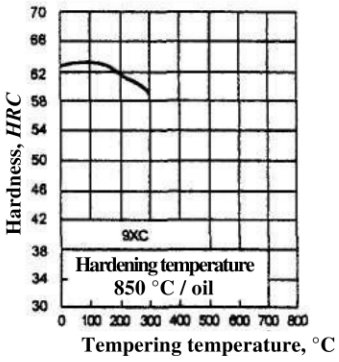


Fig. C.19

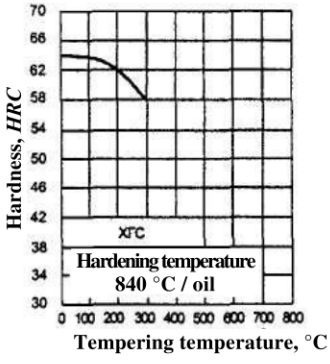


Fig. C.20

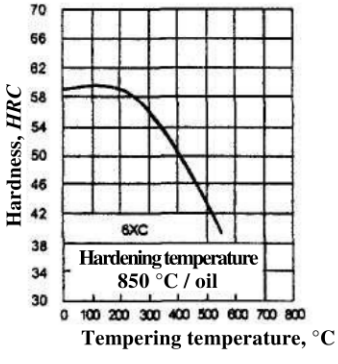


Fig. C.21

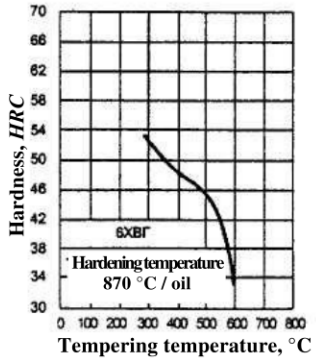


Fig. C.22

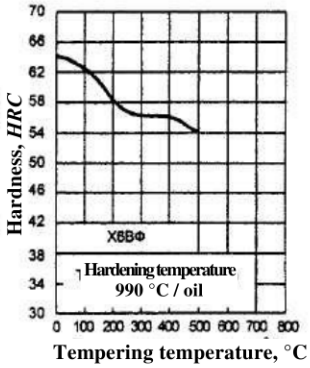


Fig. C.23

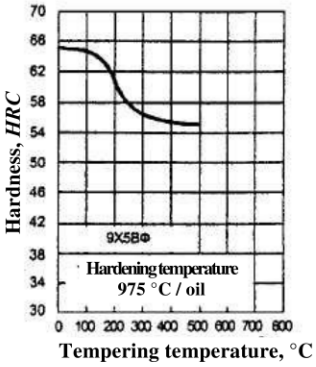


Fig. C.24

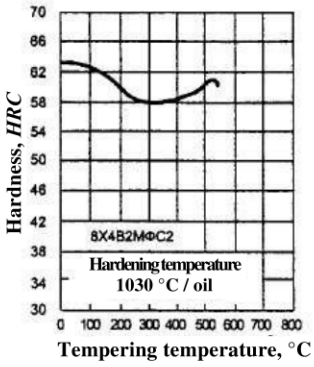


Fig. C.25

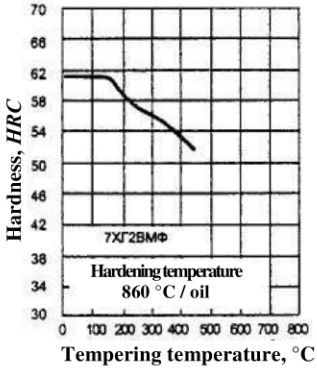


Fig. C.26

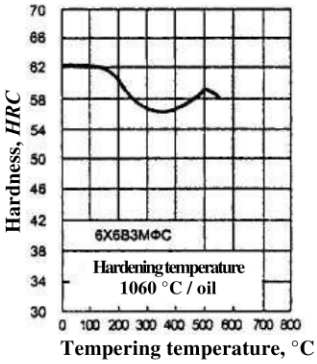


Fig. C.27

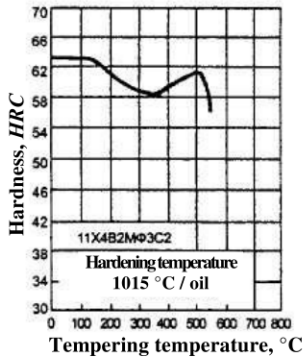


Fig. C.28

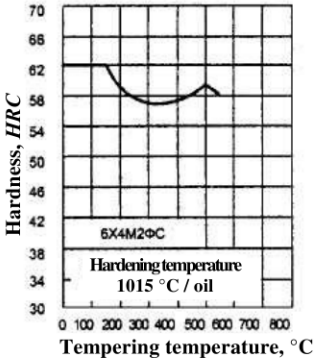


Fig. C.29

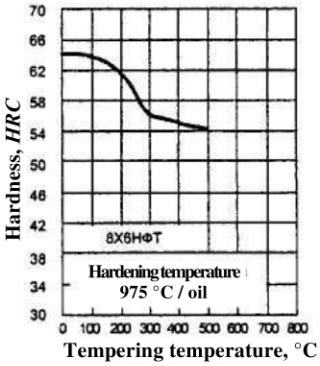


Fig. C.30

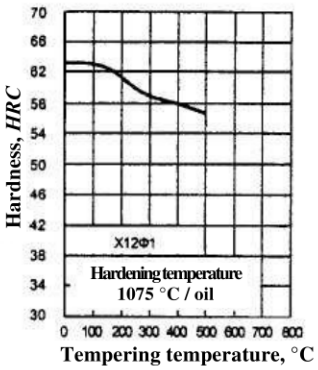


Fig. C.31

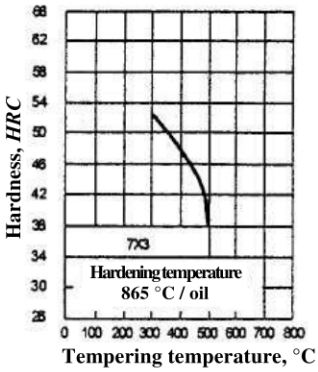


Fig. C.32

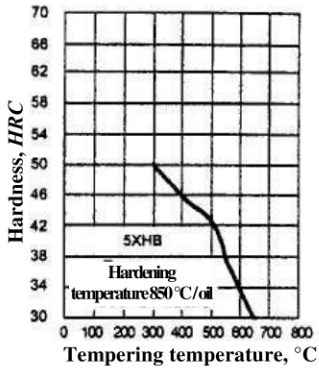


Fig. C.33

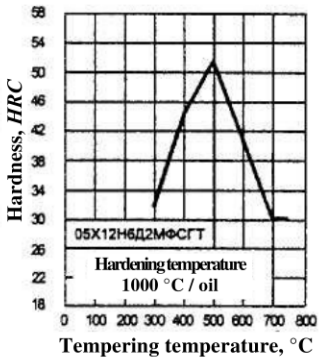


Fig. C.34

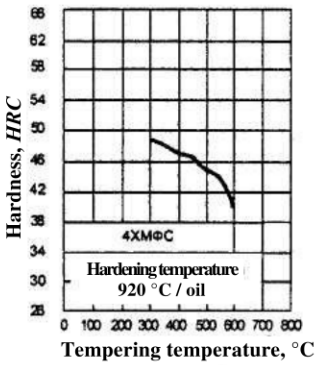


Fig. C.35

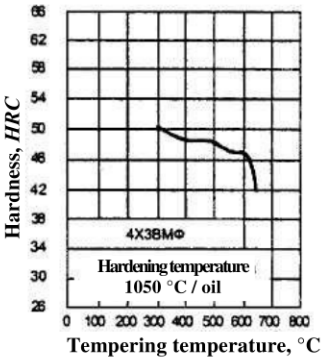


Fig. C.36

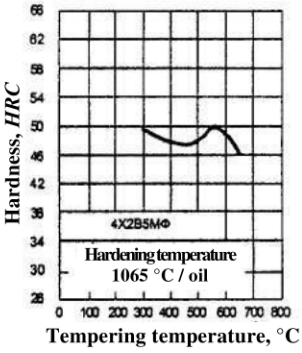


Fig. C.37

APPENDIX D
(Obligatory)

Specification of the Scale No. 1. Instruction for estimation of microstructure tool alloy steel (× 500)

The Scale No. 1 includes 10 estimates (numbers) of possible microstructure of annealed or high-temperature tempered steel.

Microstructure number from 1 to 5 designates the structures of divorced pearlite with cementite grains from 1 to 10 microns.

Microstructure number from 6 to 10 designates the structures of divorced pearlite with permanently growing quantity of lamellar pearlite (determined by its area):

number 6 contains up to 10 % of lamellar pearlite;

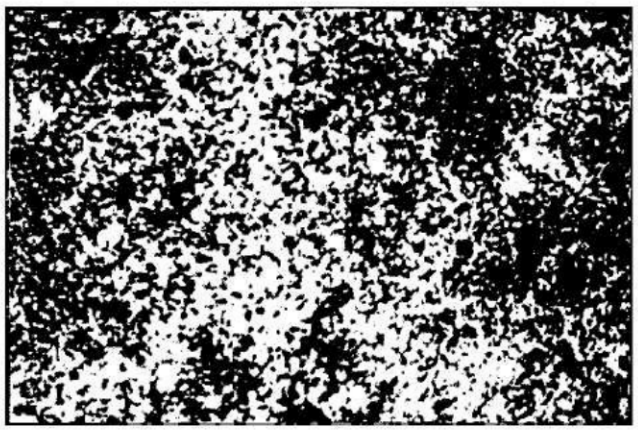
number 7 contains up to 30 %of lamellar pearlite;

number 8 contains up to 50 % of lamellar pearlite;

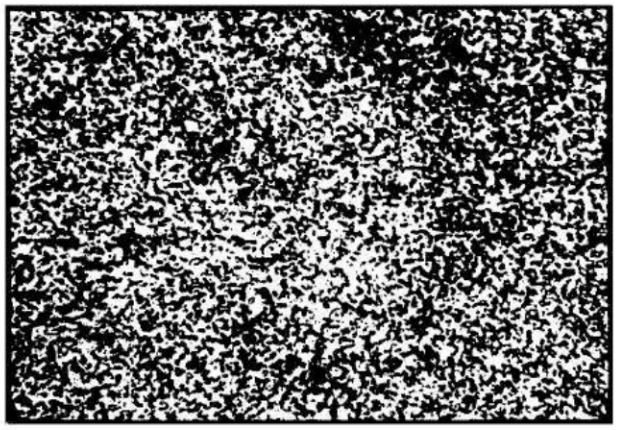
number 9 contains up to 80 %of lamellar pearlite;

number 10 contains up to 100 % of lamellar pearlite.

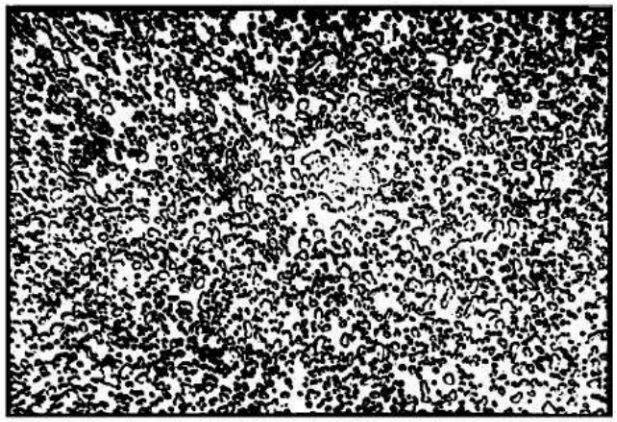
The steel microstructure that gets in between the neighboring numbers of the Scale shall be related to the greater number during estimation.



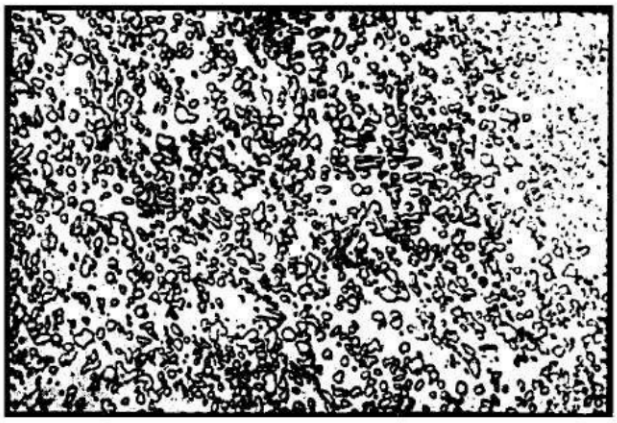
Number 1



Number 2



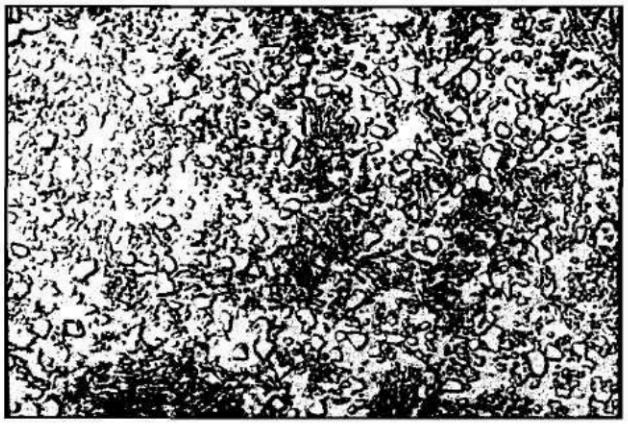
Number 3



Number 4

Number 5

Number 6



Number 7

Number 8

Number 9

Number 10

APPENDIX E
(Obligatory)

Specification of the Scale No. 2. Instruction for estimation of carbide heterogeneity of *Х12, Х12ВМФ, Х12МФ, Х12Ф1* grade steels (× 100)

The Scale No. 2 is used to estimate microstructure carbide heterogeneity of steel by 10 numbers. Each number has two microstructure standards. The top microstructure on the figure is intended for estimation of carbide heterogeneity of steel using thermally treated samples (hardening and tempering).

The bottom microstructure on the figure is intended for estimation of carbide heterogeneity of annealed steel samples.

The following Scale numbers specify the corresponding microstructures:

number 1 specifies uniform distribution of carbides;

number 2 specifies feebly marked streakiness, thin lines of carbides;

number 3 specifies streak inclusions of carbides;

number 4 specifies sharply exposed streakiness, rough lines of carbides;

number 5 specifies considerably deformed, locally torn network of carbides;

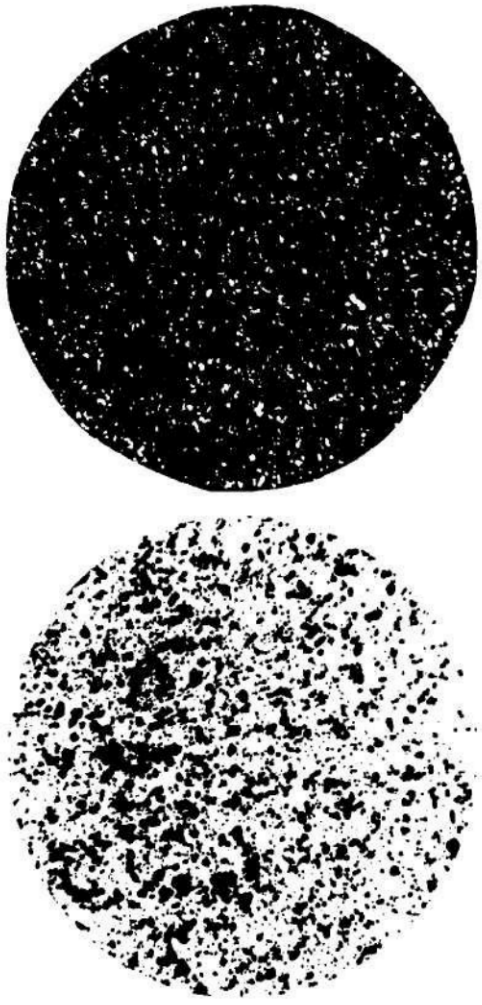
number 6 specifies deformed network of eutectic carbides;

number 7 specifies continuous deformed network of carbides with eutectic areas;

number 8 specifies weakly deformed network of carbides with eutectic areas;

number 9 specifies weakly deformed network with rough carbide eutectic;

number 10 specifies the structure corresponding to the cast steel structure.



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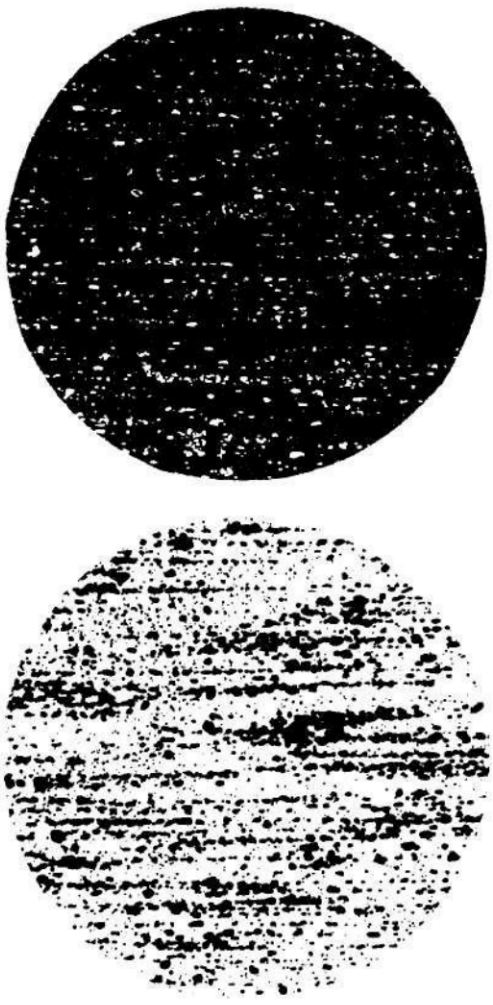
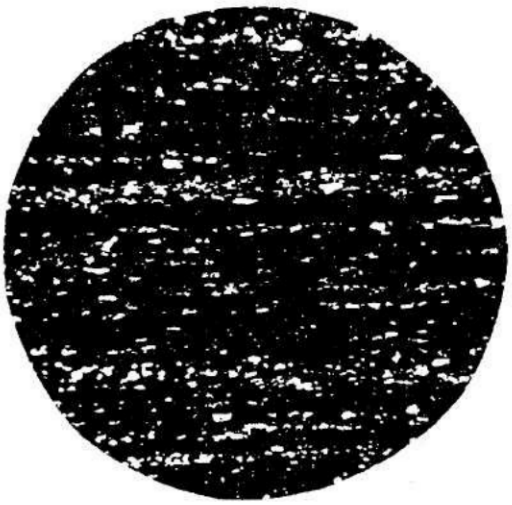
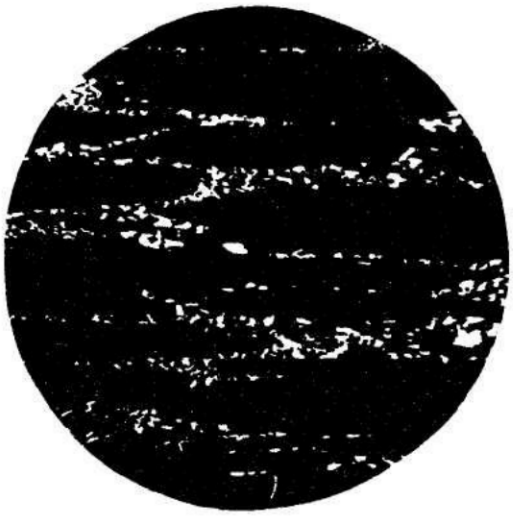


Number 2



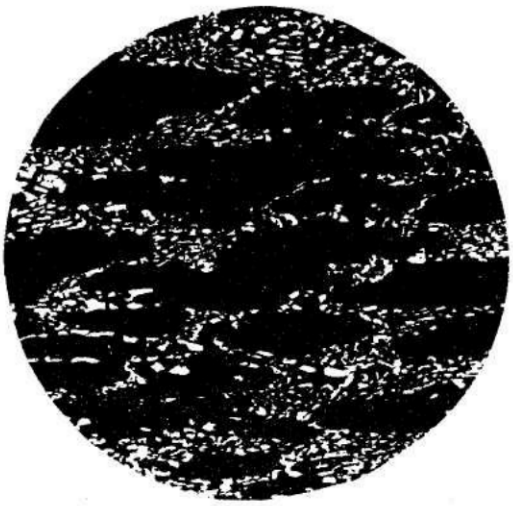
Number 3

Number 4



Number 5

Number 6



Number 7

Number 8

25

Number 9

Number 10

26

APPENDIX F
(Obligatory)

Specification of the Scale No. 3. Instruction for estimation of carbide heterogeneity of the *9Х5ВФ, 8Х6НФТ, 8Х4В2МФС2, Х6ВФ, 6Х6В3МФС, 11Х4В2МФ3С2, 6Х4М2ФС* grade steels (× 100)

The Scale No. 3 is used to estimate carbide heterogeneity of steel by 10 numbers.

The following Scale numbers specify the corresponding microstructures:

number 1 specifies uniform distribution of carbides:

number 2 specifies feebly marked streakiness;

number 3 specifies streakiness;

number 4 specifies sharply exposed streakiness;

number 5 specifies sharply exposed streakiness and clusters;

number 6 specifies sharply exposed streakiness with clusters, strongly deformed and torn network of eutectic carbides;

number 7 specifies deformed network of eutectic carbides, broken in separate places;

number 8 specifies continuous deformed network of eutectic carbides;

number 9 specifies continuous deformed network with clusters of carbides;

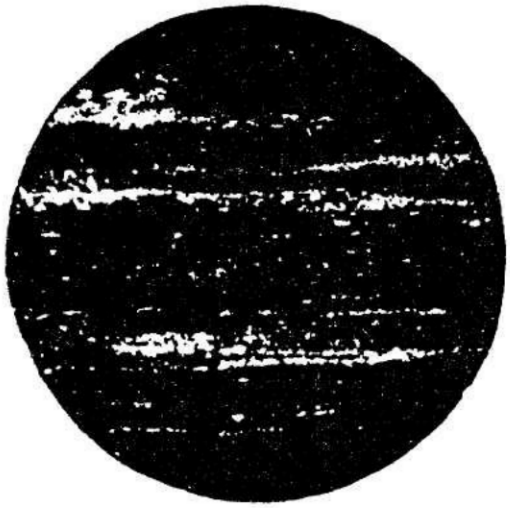
number 10 specifies the structure corresponding to cast steel structure.

Number 1

Number 2

Number 3

Number 4



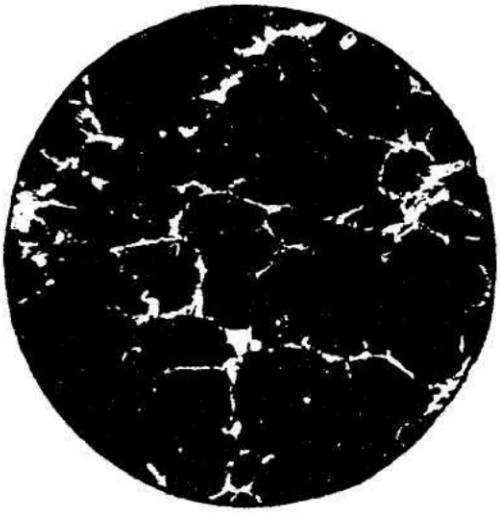
Number 5

Number 6

Number 7

Number 8

Number 9



Number 10

APPENDIX G
(Obligatory)

Specification of the Scale No. 4.
Instruction for estimation of carbide network of tool alloy steel (× 500)

The Scale No. 4 includes two standards of possible types of carbide network in steel. There are six standards of each type:

- top standard is a coarse-cellular network (average relative cell diameter is approximately equal to 0.045 mm);
- bottom standard is a close-meshed network (average relative cell diameter is approximately equal to 0.025 mm).

The standards differ by insularity measure of carbide network and correspond to the following numbers:

number 1 specifies practically uniform distribution of carbide particles;

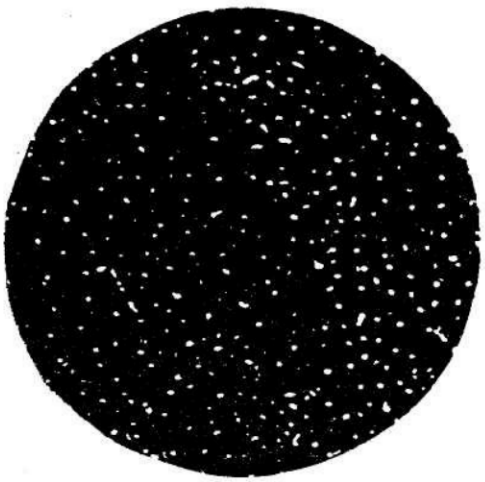
number 2 specifies separate chains of carbide particles;

number 3 specifies chains of carbide particles in the form of feebly exposed network;

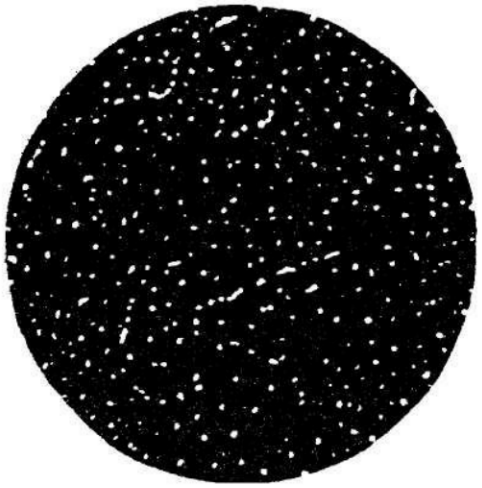
number 4 specifies chains of carbide particles in the form of distinctly exposed network;

number 5 specifies chains of carbide particles that create the network with separate completely closed cells;

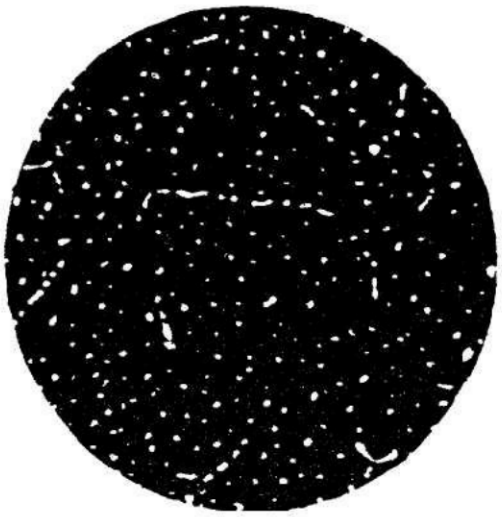
number 6 specifies carbide particles that create the network with completely closed cells. The sides of the cells have the shape of chains of carbides and continuous lines.



Number 1

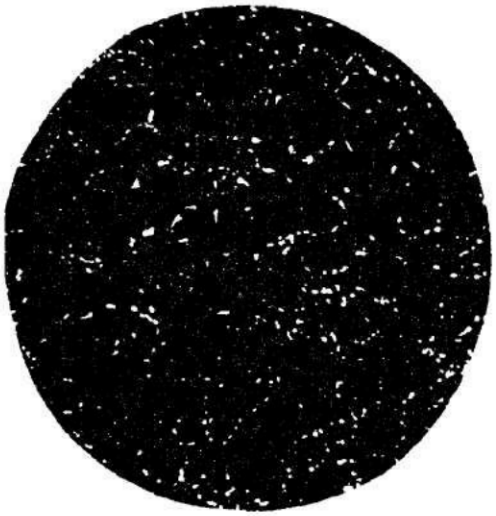


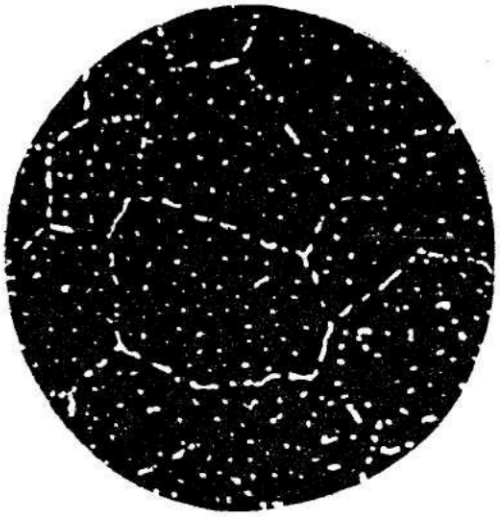
Number 2



Number 3

Number 4





Number 5

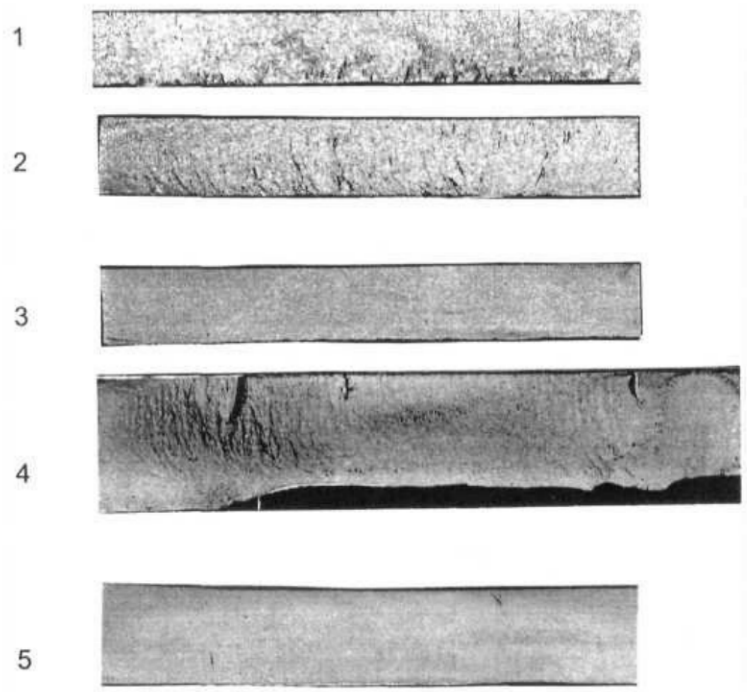
Number 6

31

APPENDIX I
(Obligatory)

Specification of the Scale No. 5.
Instruction for estimation of dimension of austenite grain of tool alloy steel using its fracture

The Scale No. 5 includes five numbers of austenite grain.



The Scale No. 5 intended for estimation of dimension of austenite grain of tool alloy steel using its fracture is specified in table I.1.

T a b l e I.1

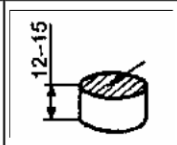
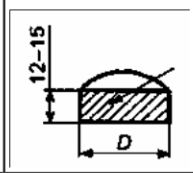
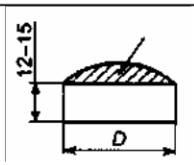
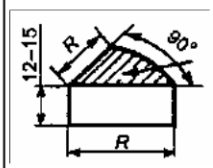
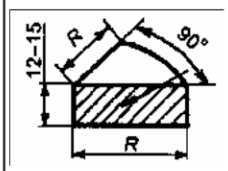
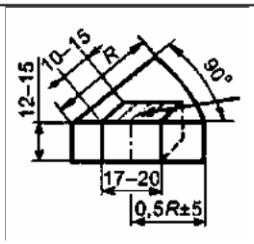
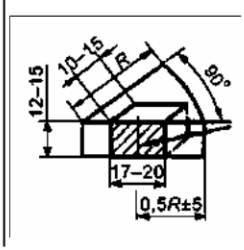
Grain number	Specification of the fracture
1	Coarse-grained fracture with bright and distinct grains
2	Medium-grained fracture with bright and distinct grains
3	Medium-grained fracture with lusterless and non-distinct grains
4	Small-grained fracture with lusterless and almost indistinguishable grains
5	Very small-grained and lusterless fracture with indistinguishable grains

APPENDIX J
(Obligatory)

Check procedure for microstructure of tool alloy steel

The sampling procedure, shape of the samples and their dimensions are specified in the table J.1.

T a b l e J.1

Figure number	The sample cut from the steel bar	Arrangement of the polished plane to the direction of drawing during rolling or forging	Dimension of the rolled steel bar, mm	Structure under check
1		Crosswise	To 25 inclusive	Divorced pearlite, carbide network, austenite grain
2		Lengthwise	To 40 inclusive	Carbide heterogeneity
3		Crosswise	From 26 to 40 inclusive	Divorced pearlite, carbide network, austenite grain
4		Crosswise	From 41 to 50 inclusive	Divorced pearlite, carbide network, austenite grain
5		Lengthwise	From 41 to 50 inclusive	Carbide heterogeneity
6		Crosswise	Over 50	Divorced pearlite, carbide network, austenite grain
7		Lengthwise	Over 50	Carbide heterogeneity

Ending of table J 1

Notes:

1 The sample template shall be cut out no less than 20 mm away from the end of the bar.

2 The polished sections shall be hatched on the figures.

3 Microstructure check of annealed metal products (divorced pearlite, carbide network) and hardened metal products (austenite grain) shall be carried using polished sections that are perpendicular to the direction of drawing during rolling and forging.

The recommended dimensions of the polished sections intended for microstructure check of rod-iron bars:

a) total cross-section (see figure 1) of the bars up to 25 mm in diameter;

b) half of cross-section of the bars from 26 to 40 mm in diameter (see figure 3);

c) quarter of cross-section of the bars from 41 to 50 mm in diameter (see figure 4);

d) the polished section shall be in compliance with figure 6 for the bars more than 51 mm in diameter.

4 The carbide heterogeneity check shall be carried out using the polished sections that are parallel to the direction of drawing during rolling and forging.

5 Carbide heterogeneity shall be checked in the point of cross-section that depends on its shape:

- in the middle of radius of the circle cross-section;
- quarter of the square side away from the middle of the side of the square;
- quarter of the strip thickness away from the middle of the wide side of the strip.

6 Samples for carbide network check, for carbide heterogeneity check and for the check of dimension of austenite grain shall be hardened from the temperatures specified in table 4 and in Appendix B of this Standard for the corresponding steel grade.

7 It is allowed:

a) to check carbide network using longitudinal polished sections. It shall be checked using only transverse polished sections in arbitral cases;

b) to check carbide heterogeneity of the *Х12, Х12ВМФ, Х12МФ, Х12Ф1* grade steels using samples subjected to hardening and tempering at a temperature of 400 °С. Annealed samples may be also used;

c) to check nonmetallic inclusions using hardened samples.

The hardening temperatures for corresponding steel grades are specified in clause 4.1.2.2 and in Appendix B of this Standard.

8 Samples shall be ground and polished using usual methods accepted by manufacturers of microsections.

The samples intended for the check of dimension of austenite grain shall be polished before hardening and slightly repolished after hardening.

9 Etching of polished sections is carried out using 4 % solution of nitric acid in ethyl alcohol.

Electro-etching of polished sections shall be carried out using 10 % water solution of oxalic acids (etching mode: current density 40 А/дм^2, etching time from 30 to 40 с) and annealed samples to check carbide heterogeneity of the metal products made of *Х12, Х12ВМФ, Х12МФ, Х12Ф1* grade steels.

10 Unetched polished sections may be used to check nonmetallic inclusions.

11 Estimation of divorced pearlite is carried out using the specified ten-number Scale No. 1 (500-fold magnification) of microstructure standards (see Appendix D).

Estimation of carbide network is carried out using the specified six-number Scale No. 4 (500-fold magnification) (see Appendix G).

Estimation of carbide heterogeneity is carried out using hundredfold magnification for:

the Scale No. 2 (Appendix E) and the *Х12, Х12ВМФ, Х12МФ, Х12Ф1* grade steels;

- the Scale No. 3 (Appendix E) and the *9Х5ВФ, 8Х6НФТ, 8Х4В2МФС2, Х6ВФ, 6Х6В3МФС, 11Х4В2МФ3С2, 6Х4М2ФС* grade steels.

Estimation of nonmetallic inclusions is carried out using 100-fold magnification for Scales specified in GOST 1778.

12 The specified magnifications used for estimation of microstructure are recommended ones. Divorced pearlite and carbide network may be checked using magnifications from 450 to 600, carbide heterogeneity and nonmetallic inclusions may be checked using magnifications from 90 to 125 depending on the microscope magnification.

13 Estimation of microstructure (divorced pearlite, carbide network, carbide heterogeneity, austenite grain) is carried out using the part of the polished section with the worst structure. All the area of the polished section shall be examined in case when dimensions of the metal products do not exceed 25 mm. Half of the ±5 mm radius area of the polished section shall be examined in case of greater dimensions of the metal products.

It shall be noted that availability of the lamellar pearlite structure caused by reduced content of carbon in the surface layer of the metal products, annealed for divorced pearlite, shall not be related to estimation of microstructure. It shall be taken into account only for estimation of decarbonized layer.

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Key words: bars, strips, hanks, tool alloy steel, classification, grades, chemical composition, steel range, characteristics, grades, packing, acceptance procedure, check methods, transportation, storage

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