UDC 669.14.018.84(083.74)

Group B32 (V 32)

USSR STATE STANDARD

Structural Alloy Steel Grades and Technical Requirements

GOST 4543-71*

This supersedes GOST 1050-60 in respect of grades 15Г, 20Г, 25Г, 30Г, 35Г, 40Г, 45Г and 50Г; GOST 1051-59 in respect of alloy steel except for surface quality and packing and GOST 4543-61.

*Reissued Jan. 1978.

Valid upto 01.01.1973.

This standard relates to hot-rolled and forged structural alloy steel with diameter or thickness upto 250 mm, (calibrated) bright-drawn steel and silver steel used after heat treatment and supplied in the form of rods, strips and bundles.

As far as norms for chemical composition are concerned, this standard applies to all other kinds of rolled sections, ingots, forgings and stampings.

This standard takes into account the CMEA recommendations PC 100-63 and PC 972-57 on standardisation.

CLASSIFICATION

1.1. Depending on chemical composition and properties, structural steel is divided into the following categories:

Quality steel,

High quality steel - A;

Very high quality steel - ШУ (Sh).

Note:

1. Electroslag steel belongs to the category of very high quality steel.

2. Steel processed in a ladle with synthetic slags was being supplied upto 1.1.74 at customer's request with its processability determined and guaranteed.

1.2. Depending on the basic alloying elements, steel is divided into: chromium steel, manganese steel, chromium-manganese steel, chromium silicon-steel, chromium-molybdenum and chromium-molybdenum-vanadium steel, chromium-vanadium steel, nickel-molybdenum and chromium-nickel steel and chromium-nickel steel with boron, chromium-silicon-manganese steel and chromium-silicon-manganese-nickel steel, chromium-manganese nickel steel and chromium-manganese-nickel steel with titanium and boron, chromium-nickel-molybdenum steel, chromium-nickel-molybdenum-vanadium steel and chromium-nickel-vanadium steel, chromium-aluminium steel and chromium-aluminium steel with molybdenum.

1.3. Depending on the kind of treatment, steel is divided into the following varieties:

a) Hot-rolled and forged steel (including steel with turned or roughened surface);

b) (Calibrated) Bright-drawn steel;

c) Round steel with special surface finish called silver steel.

1.4. Depending on application, hot-rolled and forged steel is divided into the following sub-groups:

a) For hot processing under pressure and for cold drawing (semi-finished rolled stock);

b) For cold machining (turning, planing, milling etc.) along the whole surface.

The order should specify the purpose of steel (or sub-group).

Note: Round bars meant for processing under pressure and cold drawing are supplied with turned or roughened surface by mutual consent.

(Revised edition - I.S.I. No. 5, 1977).

2. GRADES AND TECHNICAL REQUIREMENTS

2.1. Assortment of steel should correspond to the requirements of GOST 2591-71, GOST 2590-71, GOST 2879-69, GOST 103-76, GOST 1133-71, GOST 7417-75, GOST 8559-75, GOST 8560-67, GOST 14955-77, and GOST 4693-77 and other valid standards and technical documentation.

Assortment of strip steel should correspond to the documentation approved in the established manner.

Note: Hot-rolled square steel may be manufactured with side of square upto 100 mm as per GOST 2591-71 with the corners rounded off to a radius not exceeding 0.15 of side of square.

Examples of conventional designation

Hot-rolled steel of ordinary rolling accuracy B with side of square 46 mm, very high quality, grade 18ХГТ-ШІ, for hot processing under pressure (sub-group a) with heat treatment T:

Square $\frac{\text{B-46 GOST 2591-71}}{\text{18ХГТ-ШІ-а-Т GOST 4543-71}}$

-Do- strip of thickness 20 mm, width 45 mm, quality steel, grade 20ХНМ, for cold machining (sub-group - б) without heat treatment.

Strip $\frac{\text{20Х45 GOST 103-76}}{\text{20ХНМ-б-GOST 4543-71}}$
(bright - drawn)

Calibrated steel of diameter 15 mm, accuracy class 4, high quality, grade 40ХНМА, supplied in cold-worked condition H, with control of mechanical properties M and of surface quality Б as per GOST 1051-73:

Round $\frac{\text{15-4 GOST 7417-75}}{\text{40ХНМА-Н-М-Б - GOST 4543-71}}$

Note: The letter (M) is included in the numerator when steel is supplied with standardised hardness penetration.

(Revised edition - I.S.U. No. 5, 1977).

2.2. Grades and chemical composition of steel should correspond to those specified in Table 1.

Table 1 Таблица 1

Steel group Группа стали	Steel grade Марка стали	Proportion of elements, % Содержание элементов, %								
		C Углерода	Si Кремний	Mn Марганец	Cr Хром	Ni Никель	Mo Молибден	Al Алюминий	Ti Титан	V Ванадий
Хромистая Chromium steel	15Х	0,12—0,18	0,17—0,37	0,40—0,70	0,70—1,00	—	—	—	—	—
	15ХА	0,12—0,17	0,17—0,37	0,40—0,70	0,70—1,00	—	—	—	—	—
	20Х	0,17—0,23	0,17—0,37	0,50—0,80	0,70—1,00	—	—	—	—	—
	30Х	0,24—0,32	0,17—0,37	0,50—0,80	0,80—1,10	—	—	—	—	—
	30ХРА	0,27—0,33	0,17—0,37	0,50—0,80	1,00—1,30	—	—	—	—	—
	35Х	0,31—0,39	0,17—0,37	0,50—0,80	0,80—1,10	—	—	—	—	—
	38ХА	0,35—0,42	0,17—0,37	0,50—0,80	0,80—1,10	—	—	—	—	—
	40Х	0,36—0,44	0,17—0,37	0,50—0,80	0,80—1,10	—	—	—	—	—
	45Х	0,41—0,49	0,17—0,37	0,50—0,80	0,80—1,10	—	—	—	—	—
	50Х	0,46—0,54	0,17—0,37	0,50—0,80	0,80—1,10	—	—	—	—	—
Марганцовистая Magnesium steel MANGANESE STEEL	15Г	0,12—0,19	0,17—0,37	0,70—1,00	—	—	—	—	—	—
	20Г	0,17—0,24	0,17—0,37	0,70—1,00	—	—	—	—	—	—
	25Г	0,22—0,30	0,17—0,37	0,70—1,00	—	—	—	—	—	—

Table 1 Contd.

Продолжение табл. 1

Steel group Группа стали	Steel grade Марка стали	Proportion of elements, % Содержание элементов, %								
		C Углерод	Si Кремний	Mn Марганец	Cr Хром	Ni Никель	Mo Молибден	Al Алюминий	Ti Титан	V Ванадий
Марганцовистая Magnesium steel MANGANESE STEEL	30Г	0,27—0,35	0,17—0,37	0,70—1,00	—	—	—	—	—	—
	35Г	0,32—0,40	0,17—0,37	0,70—1,00	—	—	—	—	—	—
	40Г	0,37—0,45	0,17—0,37	0,70—1,00	—	—	—	—	—	—
	45Г	0,42—0,50	0,17—0,37	0,70—1,00	—	—	—	—	—	—
	50Г	0,48—0,56	0,17—0,37	0,70—1,00	—	—	—	—	—	—
	10Г2	0,07—0,15	0,17—0,37	1,20—1,60	—	—	—	—	—	—
	30Г2	0,26—0,35	0,17—0,37	1,40—1,80	—	—	—	—	—	—
	35Г2	0,31—0,39	0,17—0,37	1,40—1,80	—	—	—	—	—	—
	40Г2	0,36—0,44	0,17—0,37	1,40—1,80	—	—	—	—	—	—
	45Г2	0,41—0,49	0,17—0,37	1,40—1,80	—	—	—	—	—	—
	50Г2	0,46—0,55	0,17—0,37	1,40—1,80	—	—	—	—	—	—
Хромомарганцовая Chromium-manganese steel	18ХГ	0,15—0,21	0,17—0,37	0,90—1,20	0,90—1,20	—	—	—	—	—
	35ХГ2	0,32—0,40	0,17—0,37	1,[illegible]—1,[illegible]	0,[illegible]—0,[illegible]	—	—	—	—	—
	18ХГТ	0,17—0,23	0,17—0,37	0,80—1,10	1,00—1,30	—	—	—	0,03—0,09	—

C Si Mn Cr Ni Mo Al Ti V

Table 1 Contd.

Продолжение табл. 1

Steel group / Группа стали	Steel grade / Марка стали	Proportion of elements, % / Содержание элементов, %								
		C / Углерод	Si / Кремний	Mn / Марганец	Cr / Хром	Ni / Никель	Mo / Молибден	Al / Алюминий	Ti / Титан	V / Ванадий
Хромомарганцовая Chromium-manganese steel	20ХГР	0.18—0.24	0.17—0.37	0,70—1,00	0,75—1,05	—	—	—	—	—
	27ХГР	0,25—0,31	0.17—0.37	0,70—1,00	0,70—1,00	—	—	—		—
	25ХГТ	0,22—0,29	0.17—0.37	0,80—1,10	1,00—1,30	—	—	—	0,03—0,09	—
	30ХГТ	0,24—0,32	0,17—0,37	0,80—1,10	1,00—1,30	—	—	—	0,03—0,09	—
	40ХГТР	0,38—0,45	0.17—0.37	0,80—1,00	0,80—1,10	—	—	—	0,03—0,09	—
	35ХГФ	0,31—0,38	0,17—0,37	0,95—1,25	1,00—1,30	—	—	—	—	0,06—0,12
	25ХГМ	0,23—0,29	0,17—0,37	0,90—1,20	0,90—1,20	—	0,20—0,30	—	—	—
Хромокремнистая Chromium-silicon steel	33ХС	0,29—0,37	1,00—1,40	0,30—0,60	1,30—1,60	—	—	—	—	—
	35ХС	0,34—[illegible]	1,00—[illegible]	0,30—[illegible]	1,30—[illegible]	—	—	—	—	—
	40ХС	0,37—0,45	1,20—1,60	0,30—0,60	1,30—1,60	—	—	—	—	—
Хромомолибденовая и хромомолибденованадиевая Chromium-molybdenum and chromium molybdenum-vanadium steel	15ХМ	0,11—0,18	0,17—0,37	0,40—0,70	0,80—1,10	—	0,40—0,55	—	—	—
	20ХМ	0,15—0,25	0,17—0,37	0,40—0,70	0,80—1,10	—	0,15—0,25	—	—	—
	30ХМ	0,26—0,34	0,17—0,37	0,40—0,70	0,80—1,10	—	0,15—0,25	—	—	—
		C	Si	Mn	Cr	Ni	Mo	Al	Ti	V

Table 1 Contd.

Продолжение табл. 1

Steel group Группа стали	Steel grade Марка стали	Proportion of elements, % Содержание элементов, %								
		C Углерод	Si Кремний	Mn Марганец	Cr Хром	Ni Никель	Mo Молибден	Al Алюминий	Ti Титан	V Ванадий
Chromium-molybdenum and chromium molybdenum-vanadium steel Хромомолибденовая и хромомолибденованадиевая	30ХМА	0,26—0,33	0,17—0,37	0,40—0,70	0,80—1,10	—	0,15—0,25	—	—	—
	35ХМ	0,32—0,40	0,17—0,37	0,40—0,70	0,80—1,10	—	0,15—0,25	—	—	—
	38ХМ	0,35—0,42	0,17—0,37	0,35—0,65	0,90—1,30	—	0,20—0,30	—	—	—
	30Х3МФ	0,27—0,34	0,17—0,37	0,30—0,60	2,30—2,70	—	0,20—0,30	—	—	0,06—0,12
	40ХМФА	0,37—0,41	0,17—0,37	0,40—0,70	0,80—1,10	—	0,20—0,30	—	—	0,10—0,18
Chromium-vanadium steel Хромованадиевая	15ХФ	0,12—0,18	0,17—0,37	0,40—0,70	0,60—1,10	—	—	—	—	0,06—0,12
	40ХФА	0,37—0,44	0,17—0,37	0,50—0,80	0,80—1,10	-	-	—	—	0,10—0,18
Nickel-molybdenum steel Никельмолибденовая	15Н2М (15НМ)	0,10—0,18	0,17—0,37	0,40—0,70	—	1,50—1,90	0,20—0,30	—	—	—
	20Н2М (20НМ)	0,17—0,25	0,17—0,37	0,40—0,70	—	1,50—1,90	0,20—0,30	--	—	-
Chromium-nickel and chromium-nickel steel with boron Хромоникелевая и хромоникелевая с бором	9ХН	0,17—0,23	0,17—0,37	0,40—0,70	0,45—0,75	1,00—1,40	—	—	—	—
	40ХН	0,36—0,44	0,17—0,37	0,50—0,80	0,45—0,75	1,00—1,40	—	—	—	—
		C	Si	Mn	Cr	Ni	Mo	Al	Ti	V

Table 1 Contd.

Продолжение табл. 1

Steel group Группа стали	Steel grade Марка стали	Proportion of elements, % Содержание элементов, %								
		C Углерод	Si Кремний	Mn Марганец	Cr Хром	Ni Никель	Mo Молибден	Al Алюминий	Ti Титан	V Ванадий
Хромоникелевая и хромоникелевая с бором Chromium-nickel and chromium-nickel steel with boron	45ХН	0,41—0,49	0,17—0,37	0,50—0,80	0,45—0,75	1,00—1,40	—	—	—	—
	50ХН	0,46—0,54	0,17—0,37	0,50—0,80	0,45—0,75	1,00—1,40	—	—	—	—
	20ХНР	0,16—0,23	0,17—0,37	0,60—0,90	0,70—1,10	0,60—1,10	—	—	—	—
	12Х2Н2	0,09—0,16	0,17—0,37	0,30—0,60	0,60—0,90	1,50—1,90	—	—	—	—
	12Х2Н3А	0,09—0,15	0,17—0,37	0,30—0,60	0,60—0,90	2,75—3,15	—	—	—	—
	20ХН3А	0,17—0,24	0,17—0,37	0,30—0,60	0,60—0,90	2,75—3,15	—	—	—	—
	30ХН3А	0,27—0,33	0,17—0,37	0,30—0,60	0,60—0,90	2,75—3,15	—	—	—	—
	12Х2Н4А	0,09—0,15	0,17—0,37	0,30—0,60	1,25—1,65	3,25—3,65	—	—	—	—
	20Х2Н4А	0,16—0,22	0,17—0,37	0,30—0,60	1,25—1,65	3,25—3,65	—	—	—	—
Хромокремнемарганцовая и хромокремнемарганцовоникелевая Chromium-silicon-manganese steel and chromium-silicon-manganese-nickel steel	20ХГСА	0,17—0,23	0,90—1,20	0,80—1,10	0,80—1,10	—	—	—	—	—
	25ХГСА	0,22—0,28	0,90—1,20	0,80—1,10	0,80—1,10	—	—	—	—	—
	30ХГС	0,28—0,35	0,90—1,20	0,80—1,10	0,80—1,10	—	—	—	—	—
		C	Si	Mn	Cr	Ni	Mo	Al	Ti	V

Table 1 Contd.
Продолжение табл. 1

Steel group Группа стали	Steel grade Марка стали	Content of elements, % Содержание элементов, %								
		C Углерод	Si Кремний	Mn Марганец	Cr Хром	Ni Никель	Mo Молибден	Al Алюминий	Ti Титан	V Ванадий
Chromium-silicon-manganese steel and chromium-silicon-manganese nickel steel Хромокремнемарганцовая и хромокремнемарганцовоникелевая	30ХГСА	0,28—0,34	0,90—1,20	0,80—1,10	0,80—1,10	—	—	—	—	—
	35ХГСА	0,32—0,39	1,10—1,40	0,80—1,10	1,10—1,40	—	—	—	—	—
	30ХГСН2А (30ХГСНА)	0,27—0,34	0,90—1,20	1,00—1,30	0,90—1,20	1,40—1,80	—	—	—	—
	15ХГН2ТА (15ХГНТА)	0,13—0,18	0,17—0,37	0,70—1,00	0,70—1,00	1,40—1,80	—	—	0,03—0,09	—
	20ХГНР	0,16—0,23	0,17—0,37	0,70—1,00	0,70—1,10	0,85—1,35	—	—	—	—
	20ХГНТР	0,18—0,24	0,17—0,37	0,80—1,10	0,40—0,70	0,40—0,70	—	—	0,03—0,09	—
Chromium-manganese-nickel steel and chromium-manganese-nickel steel with titanium and boron Хромомарганцовоникелевая с титаном и бором	38ХГН	0,35—0,43	0,17—0,37	0,80—1,10	0,50—0,80	0,70—1,00	—	—	—	—
Chromium-nickel-molybdenum steel Хромоникельмолибденовая	14Х2Н3МА	0,12—0,17	0,17—0,37	0,30—0,60	1,50—1,75	2,75—3,15	0,20—0,30	—	—	—
	20ХН2М	0,15—0,22	0,17—0,37	0,40—0,70	0,45—0,60	1,50—2,00	0,20—0,30		—	—
	30ХН2МА (30ХНМА)	0,27—0,34	0,17—0,37	0,30—0,60	0,60—0,90	1,25—1,65	0,20—0,30	—	—	—
	38Х2Н2МА (38ХНМА)	0,33—0,40	0,17—0,37	0,25—0,50	1,30—1,70	1,30—1,70	0,20—0,30	—	—	—
	40ХН2МА (40ХНМА)	0,37—0,44	0,17—0,37	0,50—0,80	0,60—0,90	1,25—1,65	0,15—0,25	—	—	—

Table 1 Contd.

Продолжение табл. 1

Steel group / Группа стали	Steel grade / Марка стали	Proportion of elements, % / Содержание элементов, %								
		C Углерод	Si Кремний	Mn Марганец	Cr Хром	Ni Никель	Mo Молибден	Al Алюминий	Ti Титан	V Ванадий
Chromium-nickel molybdenum steel / Хромоникельмолибденовая	40Х2Н2МА (40Х1НВА)	0,35–0,42	0,17–0,37	0,50–0,80	1,25–1,65	1,35–1,75	0,20–0,30	—	—	—
	38ХН3МА	0,33–0,40	0,17–0,37	0,25–0,50	0,80–1,20	2,75–3,25	0,20–0,30	—	—	—
	18Х2Н4МА (18Х2Н4ВА)	0,14–0,20	0,17–0,37	0,25–0,55	1,35–1,65	4,00–4,40	0,80–0,40	—	—	—
	25Х2Н4МА (25Х2Н4ВА)	0,21–0,28	0,17–0,37	0,25–0,55	1,35–1,65	4,00–4,40	0,80–0,40	—	—	—
Chromium-nickel-molybdenum-vanadium steel and chromium-nickel-vanadium steel / Хромоникельмолибденованадиевая и хромоникельванадиевая	30ХН2МФА (30ХН2ВФА)	0,27–0,34	0,17–0,37	0,30–0,60	0,60–0,90	2,00–2,40	0,20–0,30	—	—	0,10–0,18
	36Х2Н2МФА (36ХН1МФА)	0,33–0,40	0,17–0,37	0,25–0,50	1,30–1,70	1,30–1,70	0,30–0,10	—	—	0,10–0,18
	38ХН3МФА	0,33–0,40	0,17–0,37	0,25–0,50	1,20–1,59	3,00–3,50	0,35–0,45	—	—	0,10–0,18
	45Х2Н2МФА (45ХН2МФА)	0,42–0,50	0,17–0,37	0,50–0,80	0,80–1,10	1,30–1,80	0,20–0,30	—	—	0,10–0,18
	20ХН4ФА	0,17–0,24	0,17–0,37	0,25–0,55	0,70–1,10	3,75–4,15	—	—	—	0,10–0,18
Chromium-aluminium steel and chromium-aluminium steel with molybdenum / Хромоалюминиевая и хромоалюминиевая с молибденом	38Х2Ю (38ХЮ)	0,35–0,43	0,20–0,40	0,20–0,50	1,50–1,80	—	—	0,50–0,80	—	—
	35Х2МЮА (38ХМЮА)	0,35–0,42	0,20–0,45	0,30–0,60	1,35–1,65	—	0,15–0,25	0,70–1,10	—	—

Примечания.

1. Химический состав стали категории III должен соответствовать нормам, указанным в табл. 1 для соответствующих марок стали.

2. В обозначении марок первые две цифры указывают среднее содержание углерода в сотых долях процента, буквы за цифрами означают: Р—бор, Ю—алюминий, С—кремний, Т—титан, Ф—ванадий, Х—хром, Г—марганец, Н—никель, М—молибден, В—вольфрам. Цифры, стоящие после букв, указывают примерное содержание легирующего

C	Si	Mn	Cr	Ni	Mo	Al	Ti	V

Note: 1. Chemical composition of steel of category III should conform to the norms specified in Table 1 for the respective grades of steel.

2. In the designation of grades, the first two numerals denote the average carbon content and the letters following the numerals indicate the following:

Р - Boron, Ю - Aluminium, С - Silicon, Т - Titanium, Ф - Vanadium, Х - Chromium, Г - Manganese, Н - Nickel, М - Molybdneum, В - Tungsten.

Digits following the letters indicate the approximate contents of alloying elements in whole numbers in the units place. Absence of numeral indicates that the particular grade contains upto tp 1.5 % of the particular alloying element. The letter 'A' at the end of the grade designation indicates "high quality steel". "Very high quality" steel is indicated by the letter 'Ш' (Sh) after a dash at the end of the grade designation. For example "quality steel" is 30ХГС;

"high quality" steel is 30ХГСА and

"very high quality" steel is 30ХГС-Ш or 30ХГСА-Ш.

Steel designation as given in the earlier GOST 4543-61 and technical specifications are given in brackets.

3. Steel grades 30Г2, 35Г2, 40Г2, 45Г2 and 50Г2 may, at customer's request, be supplied with manganese content 1.2 to 1.6 %.

4. A technological addition of titanium estimated at upto 0.06 % (without allowance for wastage) may be made in the case of steel of grades 20ХГР, 20ХНР, 20ХГНР, 27ГР and 18Х2Н4МА.

5. An estimated quantity of not more than 0.005 % of boron (without allowance for wastage) is introduced into steel which includes the letter Р in its grade designation.

6. In steel of grades 38ХМ, 30ХН2МА, 28Х2Н2МА, 40Х2Н2МА, 38ХН3МА, 18Х2Н4МА, 25Х2Н4МА, and 30ХН2МФА alloyed with molybdenum may have molybdenum partly replaced with tungsten.

The combined molybdenum and tungsten content converted in terms of molybdenum must conform to the values shown in Table. This convertion is done at the rate of three parts of tungsten by weight replacing one part of molybdenum by weight.

Steel grades, 38ХВ, 30ХН2ВА, 38Х2Н2ВА, 40Х2Н2ВА, 38ХН3ВА, 18Х2Н4ВА, 25Х2Н4ВА, and 30ХН2ВФА are manufactured at customer's

request. Tungsten content in these steels should be as given below:

38XB 0.50 - 0.80%	38XH3BA 0.50 - 0.80%
30XH2BA 0.50 - 0.80%	18X2H4BA 0.80 - 1.20%
38X2H2BA 0.50 - 0.80%	25X2H4BA 0.80 - 1.20%
40X2H2BA 0.60 - 0.90%	30XH2BΦA 0.50 - 0.80%.

In these grades of steel, tungsten may be partially replaced with residual molybdenum at the rate of one part of molybdenum to 3 parts of tungsten by weight. The tungsten content on this basis should not be less than:

38XB 0.30 %	38XH3BA 0.30%
30XH2BA 0.30%	18X2H4BA 0.50%
38X2H2BA 0.30%	25X2H4BA 0.50%
40X2H2BA 0.40%	30XH2BΦA 0.30%.

7. Presence of tungsten upto 0.20 %, molybdenum upto 0.15 %, titanium upto 0.03 % (except in steels of grades listed in note 4) and vanadium upto 0.05 % in steels not alloyed with these elements does not constitute grounds for rejection unless documentation approved in the established manner specifies some other proportion of these elements.

8. Steel of grade 38XH3MΦA may be manufactured with molybdenum content of 0.20 to 0.30 %.

9. Nitrogen content in steel produced in oxygen-fed converter furnaces must not exceed:

0.006% in thin rolled sheets and in strips and

0.008% in other rolled stock

Analysis for nitrogen content should be conducted at least twice a year.

(Revised edition - I.S.I. No 5, 1977).

2.3. Proportion of phosphorus, sulphur, residual copper, nickel and

chromium in all grades of steel should not exceed the norms shown in Table 2.

Table 2

Steel category	Proportion of elements, % not more than				
	Phosphorus	Sulphur	Copper	Nickel	Chromium
Quality steel	0.035	0.035	0.30	0.30	0.30
High quality steel	0.025	0.025	0.30	0.30	0.30
Very high quality steel	0.025	0.015	0.25	0.30	0.30

Note: Phosphorus content upto 0.030% is permissible in high quality steel melted in basic open hearth furnaces and in acidlined furnaces.

2.4. Deviation in chemical composition is permissible in finished rolled stock and forgings provided the norms for mechanical properties and other requirements of the present standard are met. Permissible deviations must correspond to values specified in Table 3.

Table 3

Element	Upper limit of proportion of elements, %	Permissible deviations %	Element	Upper limit of proportion of elements, %	Permissible deviations %
Carbon	As per Table 1	±0.01	Vanadium	0.06-0.12 0.10-0.18	+0.02 ±0.02
Aluminium	As per Table 1	±0.10	Manganese	Less than 1.0 1.0 and over	±0.02 ±0.05
Silicon	Less than 1.0 1.0 and over	±0.02 ±0.05	Nickel	Less than 2.5 2.5 and over	-0.05 -0.10
Titanium	As per Table 1	±0.02			
Chromium	Less than 1.0	±0.02	Molybdenum	As per Table 1	±0.02
	1.0 and over	±0.05	Tungsten	As per Table 1	±0.05

Note: Deviation in sulphur and phosphorus contents by not more than +0.005 % each is permissible with the customer's consent.

2.5. Depending on the order, hot-rolled and forged steel may be supplied with or without heat treament. Heat treatment may take the form of annealing followed by tempering at high temperature and normalising or normalising followel by high temperature tampering. Calibrated (bright drawn) and silver steel may be supplied in the cold worked state or in the heat treated condition. (Heat treatment may consist of annealing, tempering, normalising or hardening followed by tempering).

2.6. Brinell hardness of annealed or high tempered steel with diameter or thickness over 5 mm should correspond to the norms given in Table 4.

Table 4

Таблица 4

1. Steel group Группа стали	2. Steel grade Марка стали	3. Diameter of impression, mm, not less than Диаметр отпечатка, мм, не менее	4. Brinell hardness number HB not more than Число твердости НВ, не более
Хромистая Chromium	15Х	4,5	179
	15ХА	4,5	179
	20Х	4,5	179
	30Х	4,4	187
	30ХРА	3,9	241
	35Х	4,3	197
	38ХА	4,2	207
	40Х	4,1	217
	45Х	4,0	229
	50Х	4,0	229
Марганцовистая Manganese	10Г	4,7	163
	20Г	4,5	179
	25Г	4,3	197
	30Г	4,3	197
	35Г	4,2	207
	40Г	4,2	207
	45Г	4,0	229
	50Г	4,0	229
	10Г2	4,3	197
	30Г2	4,2	207
	35Г2	4,2	207
	40Г2	4,1	217
	45Г2	4,0	229
	50Г2	4,0	229
Хромомарганцовая Chromium-manganese	18ХГ	4,4	187
	35ХГ2	4,0	229
	18ХГТ	4,1	217
	20ХГР	4,3	197
	27ХГР	4,1	217
	25ХГТ	4,1	217
	30ХГТ	4,0	229
	40ХГТР	4,0	229
	35ХГФ	4,2	207
Хромокремнистая Chromium-silicon steel	33ХС	3,9	241
	38ХС	3,8	255
	40ХС	3,8	255
Хромомолибденовая и хромомолибденованадиевая Chromium-molybdenum steel and chromium-molybdenum-vanadium steel.	15ХМ	4,5	179
	20ХМ	4,5	179
	30ХМ	4,0	229
	30ХМА	4,0	229
	35ХМ	3,9	241
	38ХМ	3,9	241
	30Х3МФ	4,0	229
	40ХМФА	3,7	269

Table 4 (contd.)

Продолжение табл. 4

1. Steel group Группа стали	2. Steel grade Марка стали	3. Diameter of impression, mm, not less than Диаметр отпечатка, мм, не менее	4. Brinell hardness number HB not more than Число твердости, НВ, не более
Хромованадиевая Chromium-vanadium steel	15ХФ	4,4	187
	40ХФА	3,9	241
Никельмолибденовая Nickel-molybdenum steel	15Н2М (15НМ)	4,3	197
Хромоникелевая и хромоникелевая с бором Chromium-nickel and chromium-nickel steel with boron	20ХН	4,3	197
	40ХН	4,2	207
	45ХН	4,2	207
	50ХН	4,2	207
	12ХН2	4,2	207
	12ХН3А	4,1	217
	20ХН3А	3,8	255
	12Х2Н4А	3,7	269
	20Х2Н4А	3,7	269
	30ХН3А	3,9	241
Хромокремнемарганцовая и хромокремнемарганцовоникелевая Chromium-silicon-manganese steel and chromium-silicon-manganese-nickel steel	20ХГСА	4,2	207
	25ХГСА	4,1	217
	30ХГС	4,0	229
	30ХГСА	4,0	229
	30ХГСН2А (30ХГСНА)	3,8	255
	35ХГСА	3,9	241
Хромомарганцовоникелевая и хромомарганцовоникелевая с титаном и бором Chromium-manganese-nickel steel and chromium-manganese-nickel-steel with titanium and boron	15ХГН2ТА (15ХГНТА)	3,7	269
	20ХГНР	4,3	197
	38ХГН	4,0	229

3. Diameter of impression mm, not less than

Table 4 Contd.

Продолжение табл. 4

1. Steel group Группа стали	2. Steel grade Марка стали	3. Диаметр отпечатка, мм, не менее	4. Число твердости, НВ, не более
Хромоникельмолибденовая Chromium-nickel molybdenum steel	14Х2Н3МА	3,7	269
	20Х1Н2М (20ХНМ)	4,0	229
	30Х1Н2МА (30ХНМА)	3,9	241
	38Х2Н2МА (38ХНМА)	3,7	269
	40ХН2МА (40ХНМА)	3,7	269
	40Х2Н2МА (40ХНМДА)	3,8	255
	38Х1Н3МА	3,7	269
	18Х2Н4МА (18Х2Н4ВА)	3,7	269
	25Х2Н4МА (25Х2Н4ВА)	3,7	269
Хромоникельвольфрамомолибденованадиевая и хромоникельванадиевая Chromium-nickel molybdenum-vanadium steel and chromium-nickel-vanadium steel	30ХН2МФА	3,7	269
	36Х2Н2МФА (36ХН1МФА)	3,7	269
	38Х1Н3МФА	3,7	269
	45Х1Н2МФА (45ХН1МФА)	3,7	269
	20ХН4ФА	3,7	269
Хромоалюминиевая и хромоалюминиевая с медным слоем Chromium-aluminium steel and chromium-aluminium steel with molybdenum	38Х2Ю (38ХЮ)	4,0	229
	38Х2МЮА (38ХМЮА)	4,0	229

4. Brinell hardness number HB not more than

Note: 1. Steel ordered in heat treated condition may, with the customer's consent, be delivered without annealing and high tempering but with hardness corresponding to the norms given in Table 4.

2. Hardness of calibrated steel in annealed or high tempered condition and also hot-rolled steel normalised with subsequent high tempering may exceed the value specified in Table 4 by 15 HB units.

3. Hardness of steel grades 20XHP, 25XГM, 20H2M(20HM) and 20XГHTP is established by mutual agreement.

4. The norm for hardness of steel manufactured in the normalized condition is established by mutual agreement between manufacturer and customer.

2.7. Hardness of cold-worked steel with diameter or thickness over 6 mm should not exceed 269 HB (Diameter of impression should be not less than 3.7 mm). Alternatively, it may be fixed by mutual agreement between the parties. This does not apply to steel of grades 15X, 15XA, 20X, 30X, 35X, 15Г, 18ХГТ, 15ХФ, and 38Х2МЮА (38ХМЮА), the hardness of which should correspond to the norms specified in Table 5;

2.5 to 2.7 (Revised edition - I.S.I. No. 5, 1977).

Table 5

Steel grade	Diameter of impression, mm	Hardness number, HB, not more than
15X, 15XA	4.1	217
20X	4.0	229
30X	3.9	241
35X	3.8	255
15Г	4.2	207
18ХГТ	4.0	229
15ХФ	4.1	217
38Х2МЮА (38ХМЮА)	3.8	255

2.8. Hardness of annealed and cold-worked calibrated (bright-drawn) steel and of silver steel of diameter upto 5 mm inclusive and of hardened and tempered steel of all dimensions is established by mutual agreement between the parties.

2.9. Mechanical properties of steel at normal temperature determined on heat treated longitudinal specimens or specimens prepared from heat treated blanks should correspond to the norms given in Table 6. Calibrated (bright-drawn) and silver steel, may be delivered with or without tests of mechanical properties depending on the order.

Chromium-nickel-molybdenum, chromium-nickel-molybdenum-vanadium steels are additionally tested for impact strength at normal temperature on type IV specimens as per GOST 9454-60. Results of additional tests are optional but are included in the certificate.

Note: Mechanical test specimens of steel delivered in hardened and tempered states are not subjected to heat treatment. Norms for mechanical properties are established by agreement between the parties.

2.10. Steel of grades 15X, 20X, 30X, 30XPA, 35X, 40X, 45X, 18XГT, 20XГP, 27XГP, 30XГT, 25XГM, 38XC, 30XMA, 40XФA, 12XH3A, 20XH3A, 12X2H4A and 30ХГСА, is supplied in accordance with the order, with standardised hardness penetration within the limits of either the full range characteristic of the particular grade (dotted line) or of the restricted range (continuous line).

Drawings 1 to 18 in annexure 1 show the two ranges of hardness penetration, rod diameters and the place where hardness is measured. These rods have the same hardness after volume hardening in water and oil as does an endwise hardened specimen, hardness being measured at the corresponding distance from the cooled end of the specimen.

Annexure 2 lists the limits of fluctuation in hardness (maximum and minimum) along the length of endwise specimens both for the restricted range and the grade-characteristic range of hardness penetration.

Table 6

Steel group	Steel grade	Heat treatment: Temperature °C: First hardening or normalizing	Heat treatment: Temperature °C: Second hardening	Heat treatment: Hardening: Cooling medium	Heat treatment: Tempering: Temperature, °C	Heat treatment: Tempering: Cooling medium	Not less than: Yield point, σ_T, kgf/mm²	Not less than: Ultimate strength, σ_B, kgf/mm²	Not less than: Relative elongation, δ_5, %	Not less than: Relative reduction of area, ψ, %	Not less than: Impact strength, a_H, kgf·m/cm²	Cross section dimensions of blanks for heat treatment (diameter of round or side of square), not more than
Chromium steel	15X 15XA	880	770-820	Water or oil	180	Air or oil	50	75	12	45	7	15
		880	770-820	Water or oil	180	Air or oil	65	80	11	40	6	15
	30X	860	-	Oil	500	Air or oil	70	90	12	45	7	25
	30XPA	900 Air 860	860	Oil	200	Air	130	160	9	40	5	-
	35X	860	-	Oil	500	Water or oil	75	93	11	45	7	25
	38XA	860	-	Oil	550	Water or oil	80	95	12	50	9	25
	40X	860	-	Oil	500	Water or oil	80	100	10	45	6	25
	45X	840	-	Oil	520	Water or oil	85	105	9	45	5	25
	50X	830	-	Oil	520	Water or oil	90	110	9	40	4	25

Table 6 Conte...

Steel group	Steel grade	Heat treatment: Hardening: Temperature °C: First hardening or normalizing	Heat treatment: Hardening: Temperature °C: Second hardening	Heat treatment: Hardening: Cooling medium	Heat treatment: Tempering: Temperature, °C	Heat treatment: Tempering: Cooling medium	Not less than: Yield point, σ_T kgf/mm²	Not less than: Ultimate strength, σ_B kgf/mm²	Not less than: Relative elongation, δ_5, %	Not less than: Relative reduction along cross-section, ψ, %	Not less than: Impact strength, a_H, kgf·m/cm²	Not less than: Cross section dimensions of blanks for heat treatment (diameter of round or side of square), mm
Manganese steel	15Г	880	-	Air	-	-	25	42	26	55	-	25
	20Г	880	-	Air	-	-	28	46	24	50	-	25
	25Г	880	-	Water or air	560	Air	30	50	22	50	9	25
	30Г	860	-	Water or air	600	Air	32	55	20	45	8	25
	35Г	860	-	Water or air	600	Air	34	57	18	45	7	25
	40Г	860	-	Water or air	600	Air	36	50	17	45	6	25
	45Г	850	-	Oil or air	600	Air	38	63	15	40	5	25
	50Г	850	-	Oil or air	600	Air	40	66	13	40	4	25
	10Г2	920	-	Air	-	-	25	43	22	50	-	25

Table 6 Contd.

Steel group	Steel grade	Heat treatment					Not less than					Cross section dimensions of blanks for heat treatment (diameter of round or side of square), mm
		Hardening			Tempering		Yield point, σ_T, kgf/mm^2	Ultimate strength, σ_B kgf/mm^2	Relative elongation, δ, %	Relative reduction along cross-section, ψ, %	Impact strength, a_H, $\frac{kgf \cdot m}{cm^2}$	
		First hardening or normalizing	Second hardening	Cooling medium	Temperature, °C	Cooling medium						
Manganese steel	30Г2	880	–	Oil or air	600	Air	35	60	15	45	–	25
	35Г2	870	–	Oil or air	650	Air	37	63	13	40	–	25
	40Г2	860	–	Oil or air	650	Air	39	67	12	40	–	25
	45Г2	850	–	Oil or air	650	Air	41	70	11	40	–	25
	50Г2	840	–	Oil or air	650	Air	43	75	11	35	–	25
Chromium-manganese steel	18ХГ	880	–	Oil	200	Air or oil	75	90	10	40	–	15
	35ХГ2	860	–	Oil	600	Water or oil	90	85	12	45	8	25
	18ХГТ	880-950 Air	870	Oil	200	Water or oil	90	100	9	50	8	–
	20ХГР	860	–	Oil	200	Water or oil	80	100	9	50	8	15

Table 6 (cont.)

Steel group	Steel grade	Heat treatment: Hardening: First hardening or normalizing	Hardening: Second hardening	Hardening: Cooling medium	Tempering: Temperature, °C	Tempering: Cooling medium	Not less than: Yield point, σ_T, kgf/mm²	Not less than: Ultimate strength, σ_B, kgf/mm²	Not less than: Relative elongation, δ_5, %	Not less than: Relative reduction along cross-section, ψ, %	Not less than: Impact strength, a_H, $\frac{kgf \cdot m}{cm^2}$	Cross section of diameter of blanks for heat treatment (diameter of round or side of square), mm
Chromium-manganese steel	27ХГР	870	-	Oil	200	Air	120	140	8	45	6	15
	25ХГТ	880-950 Air	850	Oil	200	Water or oil	100 110	130 150	10 9	50 45	7 6	-
	30ХГТ	880-950 Air	850	Oil	200	Water or oil	130	150	9	40	6	-
	40ХГТР	840	-	Oil	550	Water or oil	80	100	11	45	8	25
	35ХГФ	870	-	Oil	630	Water or oil	80	93	14	55	8	25
	25ХГМ	860	-	Oil	200	Air	100	120	10	45	8	-
Chromium-silicon steel	33ХС	920	-	Water or oil	630	Water or oil	70	90	13	50	8	25
	38ХС	900	-	Water or oil	630	Water or oil	75	95	12	50	7	25
	40ХС	900	-	Water or oil	540	Water or oil	110	125	12	40	3.5	25
							110	135	12	40	5	25

Table 6 Cont.

Steel group	Steel grade	Heat treatment: Hardening: First hardening or normalizing	Heat treatment: Hardening: Second hardening	Heat treatment: Hardening: Cooling medium	Heat treatment: Tempering: Temperature, °C	Heat treatment: Tempering: Cooling medium	Yield point, σ_T, kgf/mm² (Not less than)	Ultimate strength σ_B, kgf/mm² (Not less than)	Relative elongation, δ, % (Not less than)	Relative reduction along cross-section, ψ, % (Not less than)	Impact strength, a_H, kgf·m/cm² (Not less than)	Cross section dimensions of blanks for heat treatment (diameter of round or side of square), mm, not more than
Chromium-molybdenum and Chromium-molybdenum-vanadium steel	15XM	880	-	Air	650	Air	28	45	21	55	12	30
	20XM	880	-	Water or oil	500	Air	60	80	12	50	9	15
	30XM	880	-	Oil	540	Water or oil	75	95	11	45	8	15
	30XMA	880	-	Oil	540	Water or oil	75	95	12	50	9	15
	35XM	850	-	Oil	560	Water or oil	85	95	12	45	8	25
	38XM	850	-	Oil	580	Air	90	100	11	45	7	25
	30X3MΦ	870	-	Oil	620	Water or oil	95	100	12	55	10	25
	40XMΦA	860	-	Oil	580	oil	95	105	13	50	9	25
Chromium-vanadium steel	15XΦ	880	760-810	Water or oil	180	Air or oil	55	75	13	50	8	15
	40XΦA	880	-	Oil	650	Water or oil	75	90	10	50	9	25

Table 6 Contd.

Steel group	Steel grade	Heat treatment: Hardening: First hardening or normalizing	Heat treatment: Hardening: Second hardening	Heat treatment: Hardening: Cooling medium	Heat treatment: Tempering: Temperature, °C	Heat treatment: Tempering: Cooling medium	Not less than: Yield point, σ_t, kgf/mm²	Not less than: Ultimate strength, σ_b, kgf/mm²	Not less than: Relative elongation, δ_5, %	Not less than: Relative reduction along cross-section, ψ, %	Not less than: Impact strength, a_H, $\frac{kgf.m}{cm^2}$	Cross section dimensions of blanks for heat treatment (diameter of round or side of square), mm
Nickel-molybdenum steel	15H2M (15HM)	860	770-820	Oil	180	Air	65	85	11	50	8	15
	20H2M (20HM)	860	-	Oil	180	Air	70	90	10	50	8	15
Chromium-nickel steel with boron	20XH	880	790-810	Water or air	400	Water or oil	60	80	12	60	8	10
	40XH	820	-	Water or air	500	Water or oil	60	100	11	45	7	25
	45XF	820	-	Water or air	530	Water or oil	85	105	10	45	7	25
	50XH	820	-	Water or air	530	Water or oil	90	110	9	40	5	25
	20XHP	930-950 Air	780-830	Oil	200	Air or oil	100	120	10	50	9	15
	12Kh2	860	760-810	Water or oil	180	Air or oil	60	80	12	60	9	15
	12XH3A	860	760-810	Water or oil	180	Air or oil	70	95	11	55	9	15

Table 6 Cont.

Steel group	Steel grade	Heat treatment					Not less than					Cross section dimensions of blanks for heat treatment (diameter of round or side of square), mm
		Hardening			Tempering		Yield point, σ_T, kgf/mm²	Ultimate strength, σ_B, kgf/mm²	Relative elongation, δ_5, %	Relative reduction along cross-section, ψ, %	Impact strength, a_H, $\frac{kgf \cdot m}{cm^2}$	
		First hardening or normalizing	Second hardening	Cooling medium	Temperature, °C	Cooling medium						
Chromium-nickel steel with boron	20ХН3А	820	-	Oil	500	Water or oil	75	95	12	55	11	15
	12Х2Н4А	860	760-800	Oil	180	Air or oil	95	115	10	50	9	15
	20Х2Н4А	860	730	Oil	180	Air or oil	110	130	9	45	8	15
	30ХН3А	820	-	Oil	530	Water or oil	80	100	10	50	3	25
Chromium-silicon-manganese-nickel steel	20ХГСА	880	-	Oil	500	Water or oil	65	80	12	45	7	15
	25ХГСА	880	-	Oil	430	Water or oil	85	110	10	40	6	15
	30ХГС	880	-	Oil	540	Water or oil	85	110	10	45	4.5	25
	30ХГСА	880	-	Oil	540	Water or oil	85	110	10	45	5	25
	35ХГСА	Isothermal hardening at 880°C in a mixture of potassium and sodium nitrates having a temperature of 280°C to 310°C, cooling in air.										
	30ХГСН2А (30ХГСНА)	950 oil 700 air 900	890	Oil	230	Air or oil	130	165	9	40	4	-
			-	Oil	260	Air or oil	140	165	9	45	6	-

Steel group	Steel grade	Heat treatment					Yield point, σ_T, kgf/mm²	Ultimate strength, σ_b, kgf/mm²	Relative elongation, δ, %	Relative reduction along cross-section, ψ, %	Impact strength, KCU, kgf·m/cm²	Cross section dimensions of blanks for heat treatment (diameter of round or side of square), mm
		First hardening or normalizing	Hardening: Second hardening	Hardening: Cooling medium	Tempering: Temperature °C	Tempering: Cooling medium	Not less than					
Chromium-manganese-nickel steel and chromium-boron steel with high hardenability	15ХГН2ТА (15ХГНТА)	960 air	840	Oil	180	Air or oil	75	95	11	55	10	15
	20ХГНР	930-950 air	780-830	Oil	200	Air or oil	110	130	10	50	9	15
	20ХГНТР	850	-	Oil	200	Oil	100	120	9	50	8	15
	38ХГН	850	-	Oil	570	Water or oil	70	90	12	45	10	25
Chromium-nickel-molybdenum steel[1]	14Х2Н3МА	880	770	Oil	180	Air	90	100	10	45	8	15
	20ХН2М (20ХНМ)	860	780	Oil	200	Water or oil	70	90	11	50	8	15
	30ХН2МА (30ХНМА)	860	-	Oil	530	Air	80	100	10	45	8	15
	38Х2Н2МА (38ХНМА)	870	-	Oil	580	Air or oil	95	110	12	50	8	25
	40ХН2МА (40ХНМА)	850	-	Oil	620	Water or oil	95 85	110 100	12 12	50 55	8 10	25 25
	40Х2Н2МА (40Х1НВА)	870	-	Oil	600	Water or oil	95	110	10	45	8	25
	38ХНЗМА	850	-	Oil	590	Air	100	110	12	50	8	25

Continued

Steel group	Steel grade	Heat treatment					Not more than						Cross section of blanks for heat treatment (diameter of round or side of square), mm
		First hardening or normalizing	Second hardening	Cooling medium	Tempering temperature, °C	Cooling medium	Yield point, σ_T, kgf/mm²	Ultimate strength, σ_b, kgf/mm²	Relative elongation, δ_5, %	Relative reduction along cross-section, ψ, %	Impact strength, a_H, kgf·m/cm²		
Cr, Mn, Mo steel	18Х2Н4МА (13Х2Н4ВА)	950 950	860 860	Air oil	200 550	Air or oil	85 80	115 105	12 12	50 50	10 12		15 15
	25Х2Н4МА (20Х2Н4ВА)	Air 850	-	Oil	560	Oil	95	110	11	45	9		25
Cr, Mn, Ni, Mo and V steel	30ХН2МФА	860	-	Oil	680	Air	80	90	10	40	9		25
	36Х2Н2МФА (36ХН2МФА)	850	-	Oil	600	Air	110	120	12	50	8		25
	32ХН3МФА	850	-	Oil	600	Air	110	120	12	50	8		25
	45ХН2МФА (45ХНМФА)	860	-	Oil	460	Oil	130	145	7	35	4		-
	20ХН4ФА	850	-	Oil	650	Water	70	90	12	50	10		25
Cr Al with Mo and Cr Al Mo	38Х2Ю (38ХЮ)	930	-	Water or oil	630	Water or oil	75	90	10	45	8		30
	38Х2МЮА (38ХМЮА)	940	-	Water or oil	640	Water or oil	85	100	14	50	9		30

Note: 1. The following deviations in heating temperature are permissible in the course of heat treatment of blanks to the schedules specified in Table 6.

In hardening ± 15°C

In low tempering ± 30°C

In high tempering ± 50°C

2. Blanks of steel grade 18Х2Н4МА cut out of rods with diameter or thickness 80 mm and over are hardened in air inside a casing.

Limits of variation in hardness (maximum and minimum values) along the length of endwise hardened specimens may be changed by mutual consent.

3. Norms for mechanical properties relate to specimens taken from rods of diameter or thickness upto 80 mm inclusive.

While testing rods of diameter or thickness over 80 upto 150 mm shortfalls are acceptable to the extent of 2 % in relative elongation, 2 % in relative reduction and 10 % in impact strength compared to the norms specified in Table 6.

In the case of rods of diameter or thickness 151 mm and over, these allowances are 3 %, 10 % and 15 % respectively.

Norms for mechanical properties of specimens of steel rods of diameter or thickness 100 mm re-rolled or re-forged into a square of dimension 90 to 100 mm, should correspond to the values specified in Table 6.

In the case of steel with standardised ultimate strength of not less than 120 kgf/mm^2, a reduction of 1 kgf.m /cm^2 in the impact strength norms together with a simultaneous increase of at least 10 kgf/mm^2 in the ultimate strength is acceptable.

4. Impact strength norms for type I specimens as per GOST 9454-60 are as given in GOST 9454-60.

5. The heat treatment schedule indicated in Table 6 may be altered with corresponding correction of norms for mechanical properties by mutual consent while determining mechanical properties of steel.

6. Steel may be normalised before it is hardened. If the customer agrees and specifies in the order that steel is intended to be hardened by high frequency current, normalising may be carried out before hardening.

7. Tests on all grades of steel may be conducted after a single hardening operation provided the norms given in Table 6 are met.

8. If, during the tensile test, it is not possible to detect the yield portion and it becomes impossible to determine the yield point (σ_T), the conventional yield point ($\sigma_{0.2}$) may be determined.

9. Rods of cross-section less than those specified in Table 6 are heat treated to the full cross-section of rolled product.

10. In the last column with the heading "cross-section dimensions of blanks for heat treatment (diameter of round or side of square)" the minus sign "-" denotes that heat treatment has been carried out on finished specimens.

Norms for hardness penetration for 30 X PA grade steel are established by mutual consent.

Note:

1. When steel is supplied after checking hardness penetration, test for mechanical properties may, with the customer's consent, be omitted provided the manufacturer guarantees conformity of these properties with the norms specified in Table 6

2. Test for hardness penetration on all grades of steel except those containing boron may be omitted, provided conformity of hardness penetration norms with the requirements of the present standard is guaranteed.

Limits of variation in hardness (maximum and minimum) along the length of endwise hardened specimens may be altered by mutual consent.

2.11. Localised defects on the surface of rods intended for hot processing under pressure or cold drawing (sub-group "a" including rods with turned and roughened surface) must be removed by oblique chipping or dressing to a width not less than five times the depth.

Depth of dressing to remove defects should not exceed the norms specified in Table 7.

Not more than two dressings to the maximum depth are permissible in any one section of rod of size (diameter or thickness) over 140 mm.

Isolated minor grooves, dents and ripples not exceeding half the limit deviations and minor hairline cracks of depth not exceeding 1/4 the limit deviations in the dimension, subject to a maximum of 0.2 mm, may be left undressed on the surface of rods. No hairline cracks are permitted on the surface of very high quality steel.

Note: Hairline cracks are not permitted on the surface of rods intended for making parts by hot upsetting and heading (the intended purpose of the rods should be specified in the order).

Table 7

Rod dimension, mm	Depth of dressing to remove defects, not exceeding	
	Quality steel and high quality steel	Very high quality steel
Over 200	6 % of dimension	3 % of dimension
From 140 to 200	5 % of dimension	3 % of dimension
From 80 to 140	Sum of limit deviations	Half the sum of limit deviations
Less than 80	Half the sum of limit deviations	

Note: Depth of dressing to remove defects is reckoned from the actual dimension.

2.12. Localised defects are not permitted on the surface of rods intended for cold machining (sub-group b) if their depth as determined by control filing or chipping exceeds the norms specified in Table 8.

Table 8

Rod dimension, mm	Depth of dressing to remove defects, not exceeding	
	Quality steel and high quality steel	Very high quality steel
100 and more	Sum of limit deviations	Negative tolerance
Less than 100	Negative tolerance	

Note: Depth of occurrence of defects is reckoned from the nominal dimensions.

2.9 to 2.12. (Revised edition - I.S.I. No. 5, 1977).

2.13. Surface quality of calibrated (bright-drawn) steel should correspond to the requirements of GOST 1051-73 and that of silver steel to GOST 14955-77.

2.14. Decarbonization is not permitted in steel with turned, roughened and polished surface and in silver steel including steel intended to be hardened by high frequency current.

Total depth of decarbonized layer (ferrite + transition zone) is checked, at customer's request specified in the order, in the case of steel being supplied without turning, roughening and polishing and containing more than 0.3 % of carbon (at the lower limit). This depth should not exceed 1.5 % of the diameter or thickness.

2.15. Rods should be trimmed evenly.

Note: Frayed ends and burrs are permissible on rods cut in presses, guillotine shears and by hammer.

Rods of diameter upto 140 mm and bundles of calibrated (bright-drawn) steel of diameter upto 22 mm inclusive should, if so required

by the customer, be supplied without burrs or frayed ends.

2.16. Steel, intended for hot upsetting, heading and stamping, which should be specified in the order, should be tested for upsetting, in the hot condition.

Specimens tested for upsetting must be free from ruptures and cracks.

Note: The manufacturer may skip the test for upsetting on rods of dimension over 80 mm, if he gurantees satisfactory test results at the customer's premises.

2.17. Macrostructure of steel as checked on etched templates or on fracture must be free from shrinkage cavity, porosity, bubbles, cracks, peeling, slag inclusions and hairline cracks and must conform to the requirements specified in Table 9.

Table 9

Steel category	Macrostructure, points, not exceeding							
	Central porosity	Spot uniformity	Liquation square	General spotted liquation	Liquation at the edge	Shrinkage liquation	Subcrust bubbles	Inter-crystalline cracks
Quality steel	3	3	3	1	1	1	Not permissible	
High quality steel	2	2	2	Not permissible		1		
Very high quality steel	1	1	1	Not permissible				

Note: Liquation square not exceeding 1 points is permitted in high quality steel of grades 30XГСА, 35XГСА, 25XГСА and 20XГСА. Liquation at the edge or general spotted liquation not exceeding 2 points is

permitted in quality steel and high quality steel of grades 38Х2Ю and 38ХМЮА.

2. Stratified crystallization and light contour should not exceed 3 points in very high quality steel.

3. Blisters beneath the crust at a depth of not more than half the tolerance in diameter or thickness is permissible in steels intended for cold machining.

4. Steel of grades 18Х2Н4МА and 25ХН4МА are guaranteed to be free from intercrystalline cracks for sizes upto 160 mm. The permissible extent of development of intercrystalline cracks in rods of size over 160 mm is fixed by mutual consent.

5. Macrostructure of steel may be checked by ultrasonic inspection if the manufacturer gurantees conformity of macrostructures with the requirements of clause 2.17.

2.18. Steel is supplied at customer's request:

a) To the automobile industry with carbon and alloying element content limits narrower than specified in Table 1 but without taking into account permissible deviations in carbon content envisaged in Table 3.

b) With silver and phosphrous content not more than 0.025 % each in quality steel. In this case the letter 'А' is added at the end of the steel grade designation.

c) With sulphur content not more than 0.015 % in high quality steel.

d) With phosphorus content not more than 0.02 % in high quality steel and very high quality steel.

e) With limited sulphur content at the lower limit, not less than 0.020 % in quality steel.

f) With copper content not more than 0.20 % in steel intended for hot processing under pressure.

g) In etched condition.

h) With standardised purity as to non-metallic inclusions.

i) With mechanical properties checked on transverse specimens in steel of dimension more than 80 mm.

j) With standardised hardness, not envisaged in Table 4 as supplied and with hardness lower than specified in Table 4.

k) With impact strength checked at normal temperature on type VI specimens as per GOST 9454-60 for steel groups not specified in clause 2.9.

m) With impact strength checked a temperature of minus 60° and viscous component content checked on fracture of type I specimen as per GOST 9454-60 (for steel intended for machines and mechanisms to be used in the norther zone).

n) With standardised purity of steel as to hairline cracks detected on the surface of parts by magnetic or etching method. Contamination in steel should not exceed the norms specified in Table 10.

o) With standardised grain size of austenitic steel which should not be larger than No. 5.

p) With processability checked.

q) With standardised hardness penetration for steel grades not included in clause 2.10.

r) With macrostructure checked both by etching and by fracture.

s) With slating of fracture checked.

t) With streakiness, ferrite-pearlite structure and widmannstatten structure checked and

u) in improved condition (hardening + tempering).

Note: Norms for the parameters against some of the subclauses and the inspection methods to be used in respect of some of the subclauses above must be adopted as stipulated in the special standards relating to rolled stock. Alternatively they must be settled by mutual consent

or formulated in appropriate technical documentation approved in the established manner. This applies to parameters against subclauses a, h, i, g, k, l, q, r, s and t. and inspection methods for subclauses .

i) - purity as to hairline cracks,

p) - processability,

s) - slated fracture and

t) - streakiness and widmannstatten structure.

Table 10

Total area of surface of the part being checked, cm^2	Permissible number of hairline cracks in steel			Maximum length of hairline cracks in steel, mm		Total length of hairline cracks in steel, mm		
	Quality steel	High quality steel	Very high quality steel	High quality or very high quality steel	Very high quality steel	Quality steel	High quality steel	Very high quality steel
upto 50	5	2	1	6	3	10	5	3
over 50 to 100	6	3	2	7	3	10	8	5
100 to 200	8	4	2	8	4	20	10	6
200 to 300	10	6	3	9	4	30	15	8
300 to 400	11	8	4	10	5	40	20	10
400 to 600	12	9	5	12	6	60	30	18
600 to 800	13	10	5	14	6	80	40	24
800 to 1000	15	11	6	15	7	100	50	30

Note: For every subsequent 200 cm^2 of checked surface area of finished parts having area in excess of 1000 cm^2, additional allowance may be made at the rate of not more than one hairline crack, of length not more than the value indicated for an area of 1000 cm^2 with a corresponding increase in the total length of hairline cracks.

2. Parts having surface area exceeding 200 cm^2 may have not more than five hairline cracks per 10 cm^2 of surface area in the case of quality and high quality steel and not more than three in the case of very high quality steel.

(Revised edition - I.S.I. No. 5, 1977).

3. Acceptance Rules

3.1. General acceptance rules for steel are as per GOST 7566-69.

3.2. Rods, strips and bundles are supplied in batches consisting of steel from a single melt having a single dimension and heat treated to a single schedule.

3.3. The following sampling scale is adopted for checking the quality of steel from a batch of rods, strips and bundles.

a) For chemical analysis - one specimen from melt or ladle in accordance with GOST 7565-73.

b) For checking surface quality and dimensions - all rods, strips and bundles.

c) For checking macrostructure by fracture or etching - two templates out of different rods or strips.

d) For tensile test - two specimens from two rods or strips.

e) For determining impact strength - two specimens of each type from two rods or strips.

f) For upsetting - three specimens from different rods or strips.

g) For determining depth of decarbonized layer - three specimens from different rods or strips.

h) For checking hardness as delivered - 2 % of the rods and strips of size 30 mm and less subject to a minimum of five rods or strips.

i) For determining hardness penetration - one specimen from melt or ladle for steel of all grades except those containing boron; two specimens from melt or ladle for steel of grades containing boron.

j) For determining grain size - one specimen from melt or ladle for steel of all grades, exopt those containing boron; two specimens from melt or ladle for steel of grades containing boron.

4. Testing Methods

4.1. Chemical composition of steel is determined as per GOST 12344-66 to GOST 12346-66, GOST 12347-77, GOST 12348-66, GOST 12352-66, GOST 12354-66 to GOST 12357-66, and GOST 12360-66 or by other methods ensuring the corresponding accuracy.

(Revised edition - I.S.I. No. 5, 1977).

4.2. Dimensions of rods are checked with measuring instruments of appropriate accuracy.

4.3. Surface quality is checked without using magnifying devices. Brightening or etching is done if necessary. In the case of silver steel of diameter upto 3 mm inclusive, checking is done with magnification upto 10 x.

4.4. Macrostructure of steel is checked by etching or by fracture as per GOST 10243-75 and ultrasonically as per supplier's practice.

4.5. Selection of samples for mechanical testing is done as per GOST 7564-73 (variant 1).

4.6. Test for upsetting in hot condition is carried out as per GOST 8817-73.

During the test for upsetting, specimens are heated to forging temperature and upset to ⅔ the initial height.

4.7. Tensile test is carried out on cylindrical specimens of diameter 5 or 10 mm and length five times as much. Tensile test may also be carried out on actual specimens of smaller section than indicated in Table 6.

Impact strength test at normal temperature is conducted in

accordance with GOST 9454-60 on type I and type IV specimens and at a temperature of minus 60°C on type I specimens in accordance with GOST 9454-60.

The method described in annexure 3 is followed for determining viscous component percentage in fracture.

Nondestructive testing methods may be used on an agreed basis.

(Revised edition - I.S.I. No. 5. 1977).

4.8. Depth of decarbonized layer is determined by the method M in accordance with GOST 1763-68. The method T as in GOST 1763-68 may be adopted for determining the extent of decarbonized layer in calibrated (bright-drawn) steel by mutual consent.

4.9. Grain size is determined in accordance with GOST 5639-65. Grain size of cemented grades of steel is determined by the cementation method and that of improved grades by the oxidation method.

4.10. Hardenability (hardness penetration) is determined by the method of end hardening as per GOST 5657-69.

4.11. Brinell hardness test is conducted as per GOST 9012-59.

4.12. Determination of non-metallic inclusions is done as per GOST 1778-70.

4.13. When steel which has passed tests for macrostructure, hardness penetration and mechanical properties on large profiles is supplied in smaller rolled profiles, these tests may be omitted but the manufacturer must guarantee conformity of these parameters with the requirements of the present standard.

4.14. If hairline cracks are detected in even a single rod, all the metal of the particular batch is rejected.

If unsatisfactory test results are obtained in respect of even a

single parameter, the particular test is repeated on twice the number of samples drawn from the same batch. Repeat test results are final.

4.15. The testing methods specified above must be followed for control check by the customer for conformity of quality of the product with the requirements of the present standard.

5. Packing, Marking and Storage

5.1. Packing, marking and preparation of documents are carried out as per GOST 7566-67. Calibrated (bright-drawn) steel should be packed in conformity with the requirements of GOST 1051-71 and silver steel as per GOST 14955-77.

A facsimile of the State Quality Mark must be reproduced as per GOST 1.9-67 on products which have been assigned the State Quality Mark in the established manner.

(Revised edition - I.S.I. No. 5, 1977).

5.2. Minimum weight of rods in one batch (melt) is decided upon by mutual agreement.

5.3. The following colours specified in Table 11 must be painted on the packets, ends and face of rods:

of hot-rolled and forged steel at customer's request specified in the orders and

of calibrated (bright drawn) steel of all grades depending on their group by mutual consent.

Table 11

Steel group	Colour of paint
Chromium steel	Green + yellow
Mangenese steel	Brown + Blue
Chromium - mangenese steel	Blue + Black
Chromium - silicon-steel	Blue + Red
Chromium-molybdenum and chromium-molybdenum-vanadium steel	Green + Violet
Chromium-vanadium steel	Green + Black
Nickel-molybdenum steel	Yellow + Violet
Chromium-nickel and chromium-nickel with boron	Yellow + Black
Chromium-silicon-mangenese steel	Red + Violet
Chromium-nickel-molybdenum steel	Violet + Black
Chromium aluminium steel and chromium-aluminium steel with molybdenum	Aluminium

Note: Colour of paints for marking steel of other groups is decided by mutual agreement.

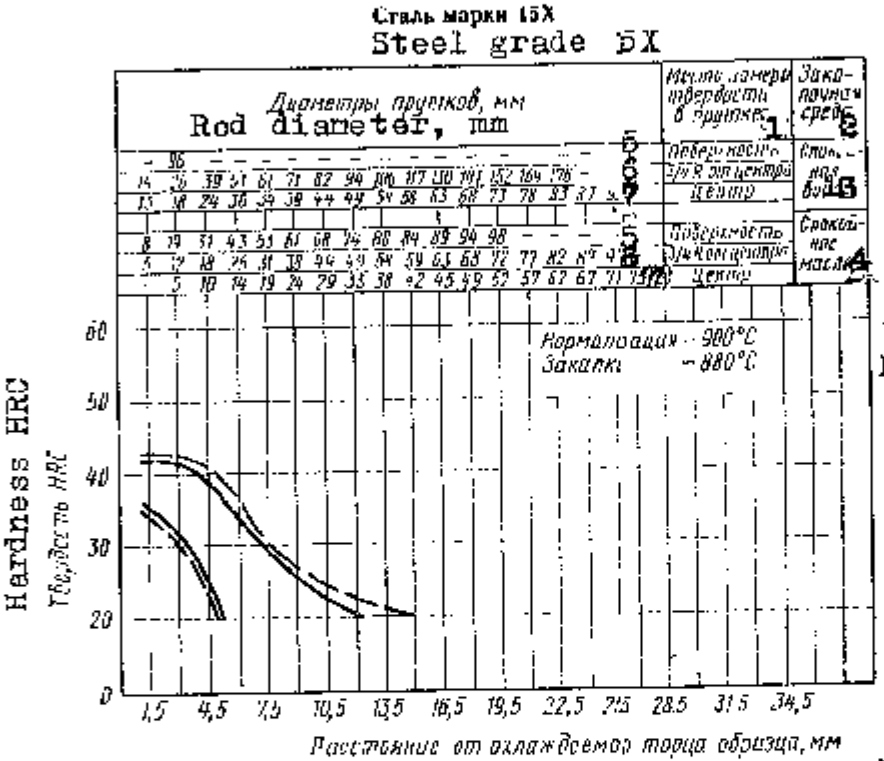
ПРИЛОЖЕНИЕ 1

Hardenability ranges of structural alloy steel. Annexure 1

ПОЛОСЫ ПРОКАЛИВАЕМОСТИ ЛЕГИРОВАННОЙ КОНСТРУКЦИОННОЙ СТАЛИ

Сталь марки 15Х

Steel grade 15X

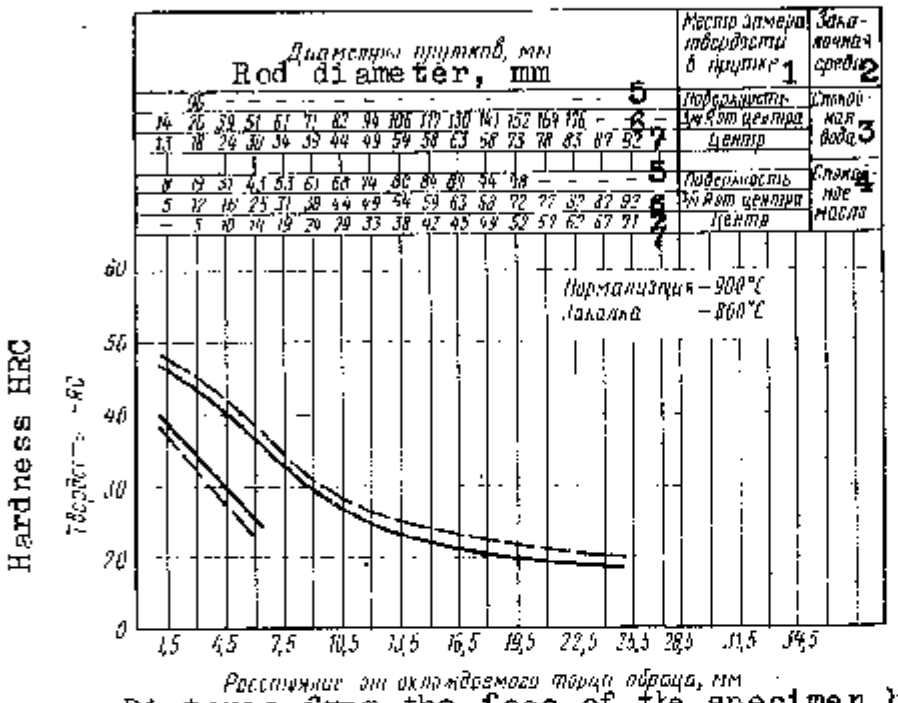


Drg. 1

1. Place where hardness of rod is measured
2. Hardening medium
3. Placid water 4. Placid oil.
5. Surface
6. 3/4 R. from centre
7. Centre

Steel grade 20K

Сталь марки 20Х

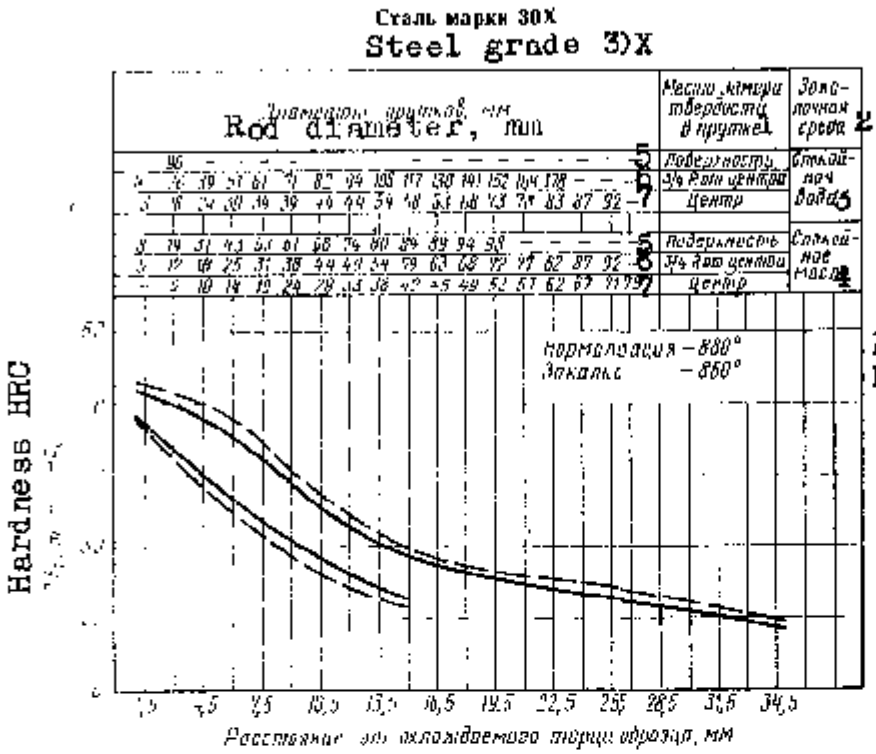


Normalization-900°C

Hardening -860°C

Drg.2

1. Place where hardness of rod is measured
2. Hardening medium
3. Placid water
4. Placid oil.
5. Surface
6. 3/4 R. from centre
7. Centre



Drg. 3.

1, Place where hardness of rod is measured

2. Hardening medium

3. Placid water

4. Placid oil

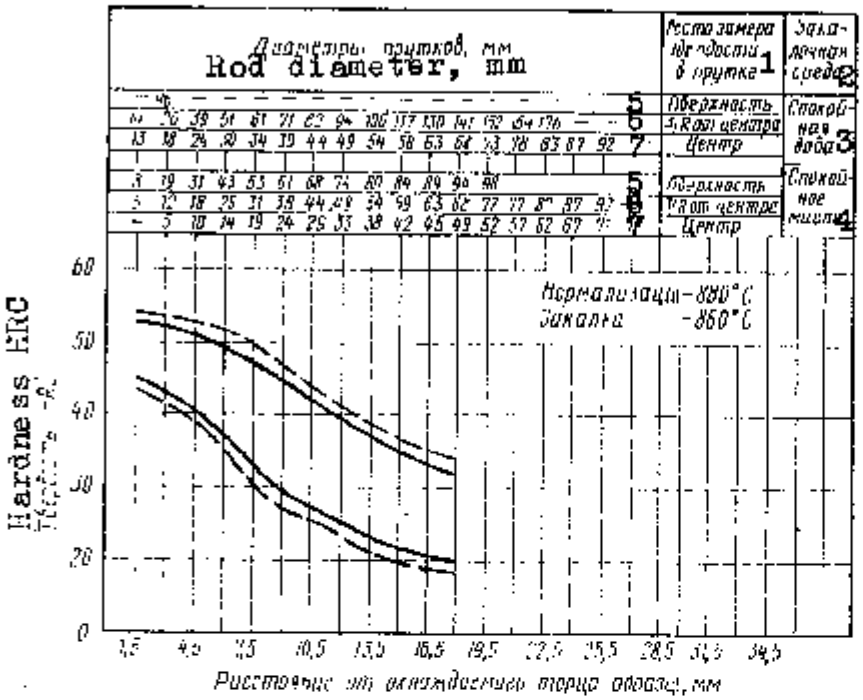
5 Surface

6. 3/4 R. from centre

7. Centre

Сталь марки 35Х

Steel grade 35X



Normalization-880°C
Hardening -860°C

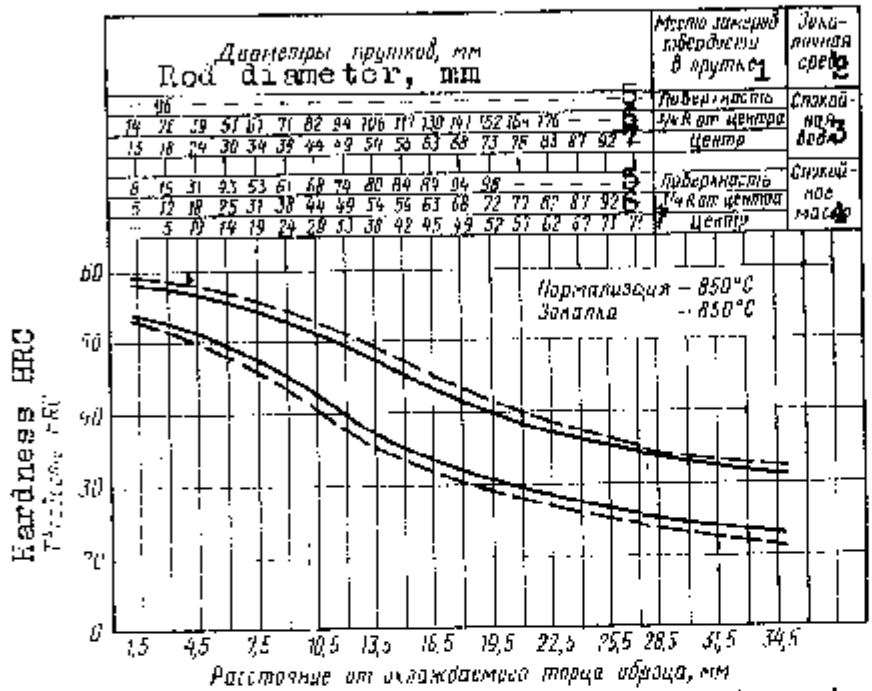
Distance from the face of the specimen being cooled, mm

Drg.4.

1. Place where hardness of rod is measured
2. Hardening medium
3. Placid water
4. Placid oil
5 Surface
6. 3/4 R. from centre
7. Centre

Сталь марки 45Х

Steel grade 45X



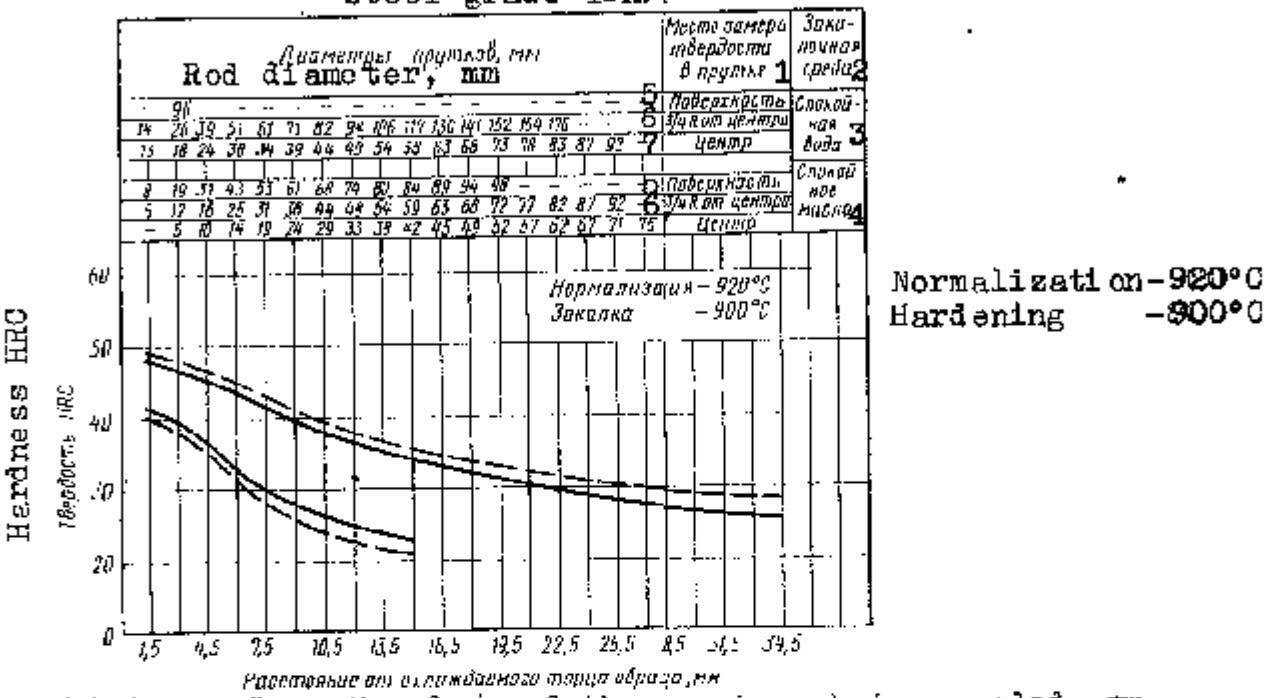
Normalization –850°C
Hardening –860°C

Drg. 6

1. Place where hardness of rod is measured
2. Hardening medium
3. Placid water
4. Placid oil
5. Surface
6. 3/4 R. from centre
7. Centre

Сталь марки 18ХГТ

Steel grade 18ХГТ



Normalization – 920°C
Hardening – 900°C

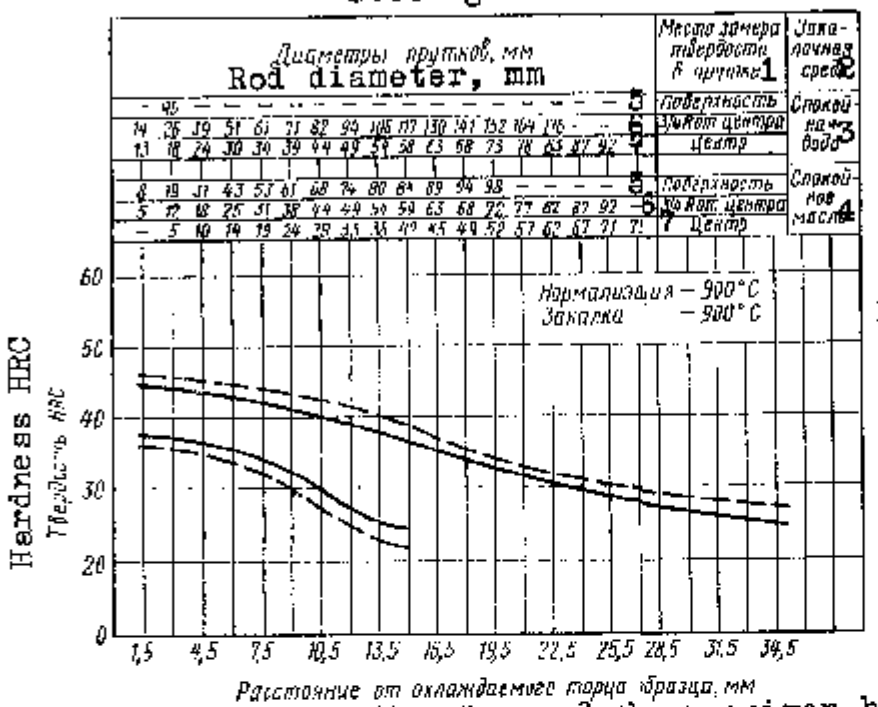
Черт 7

Drg. 7

1. Place where hardness of rod is measured
2. Hardening medium
3. Placid water
4. Placid oil
5. Surface
6. 3/4 R. from centre
7. Centre

Сталь марки 20ХГР

Steel grade 20ХГР

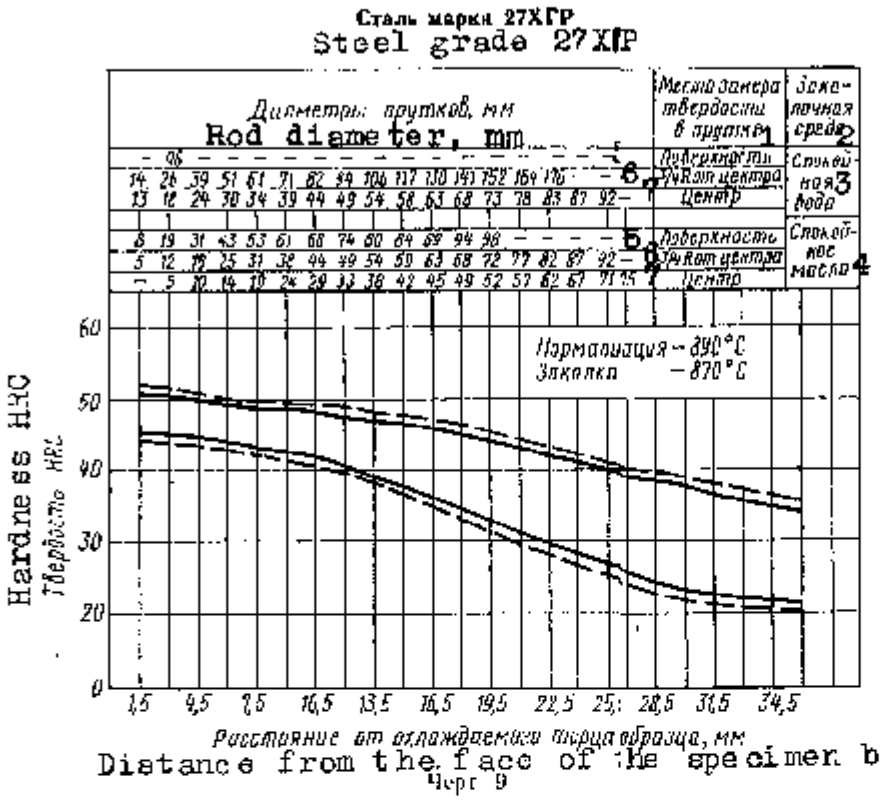


Черт. 8

Drg. 7

Normalization–900°C
Hardening –980°C

1. Place where hardness of rod is measured
2. Hardening medium
3. Placid water
4. Placid oil
5. Surface
6. 3/4 R. from centre
7. Centre



Черт 9

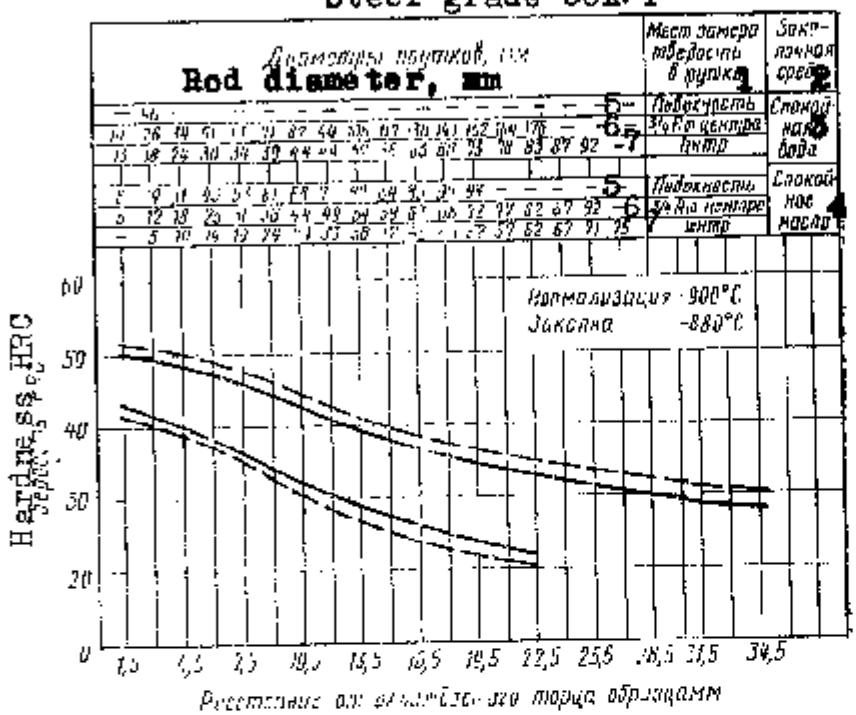
Drg. 9

Normalization – 890°C
Hardening – 870°C

1. Place where hardness of rod is measured.
2. Hardening medium.
3. Placid water
4. Placid oil.
5. Surface.
6. 3/4 R. from centre
7. Centre.

Сталь марки 30ХГТ

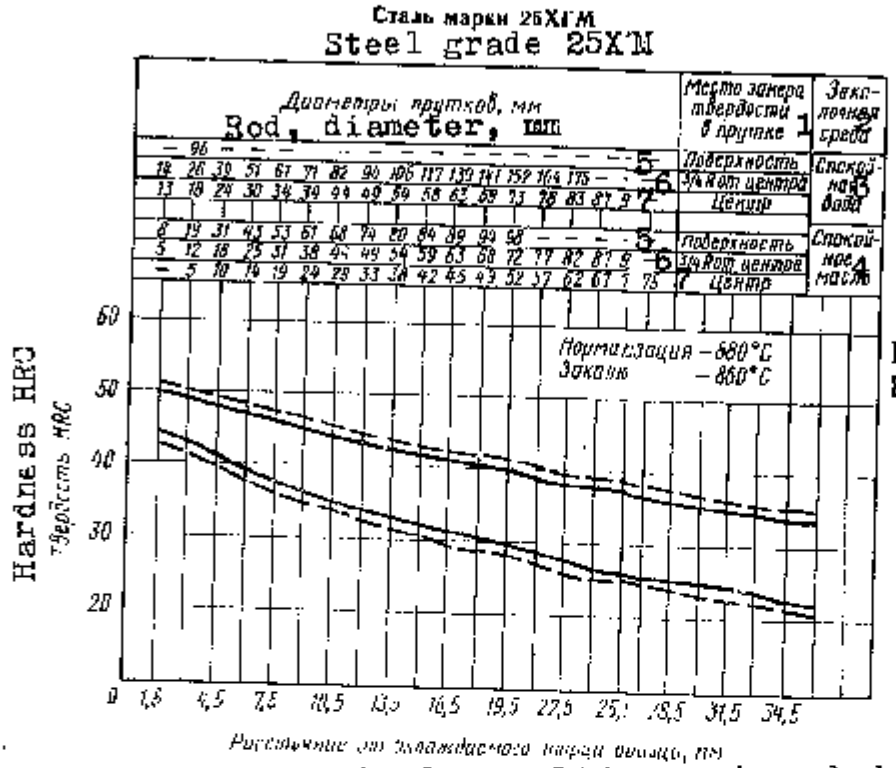
Steel grade 30ХГТ



Normalisation–900°C
Hardening –880°C

Drg. 10.

1. Place where hardness of rod is measured.
2. Hardening medium.
3. Placid water
4. Placid oil.
5. Surface.
6. 3/4 R. from centre
7. Centre.



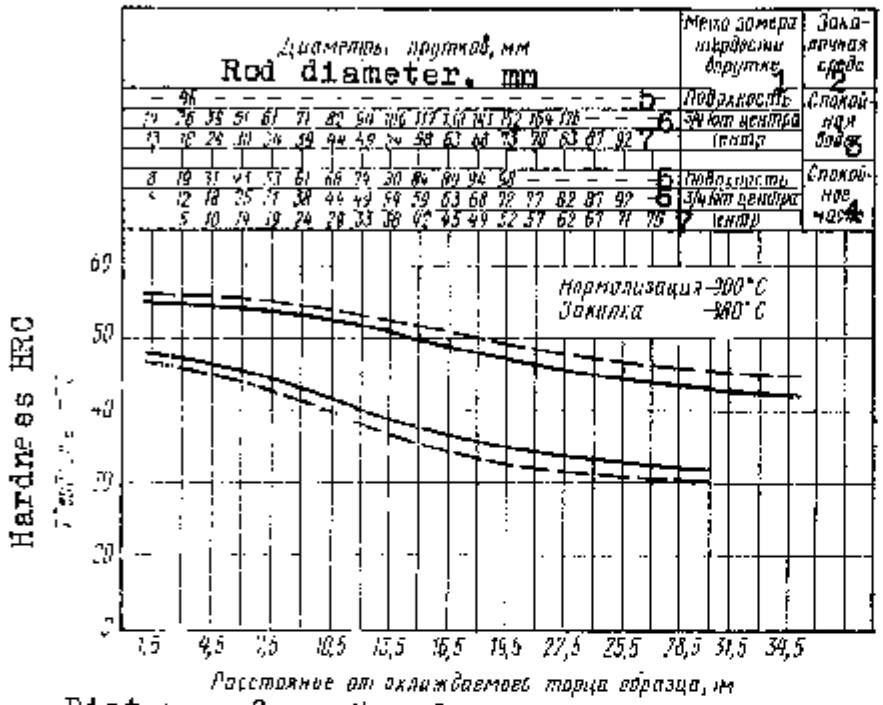
Normalization -880°C
Hardening -860°C

Distance from the face of the specimen being cooled, mm

Drg. 11.

1. Place where hardness of rod is measured.
2. Hardening medium.
3. Placid water
4. Placid oil.
5. Surface.
6. 3/4 R. from centre
7. Centre.

Сталь марки 38ХС
Steel grade 38ХС

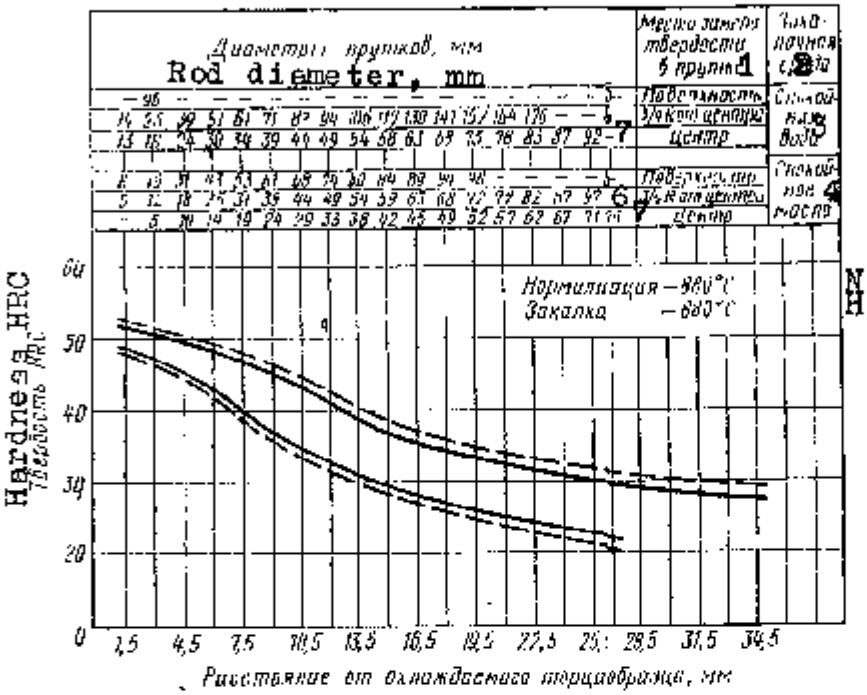


Черт. 12

Drg. 12

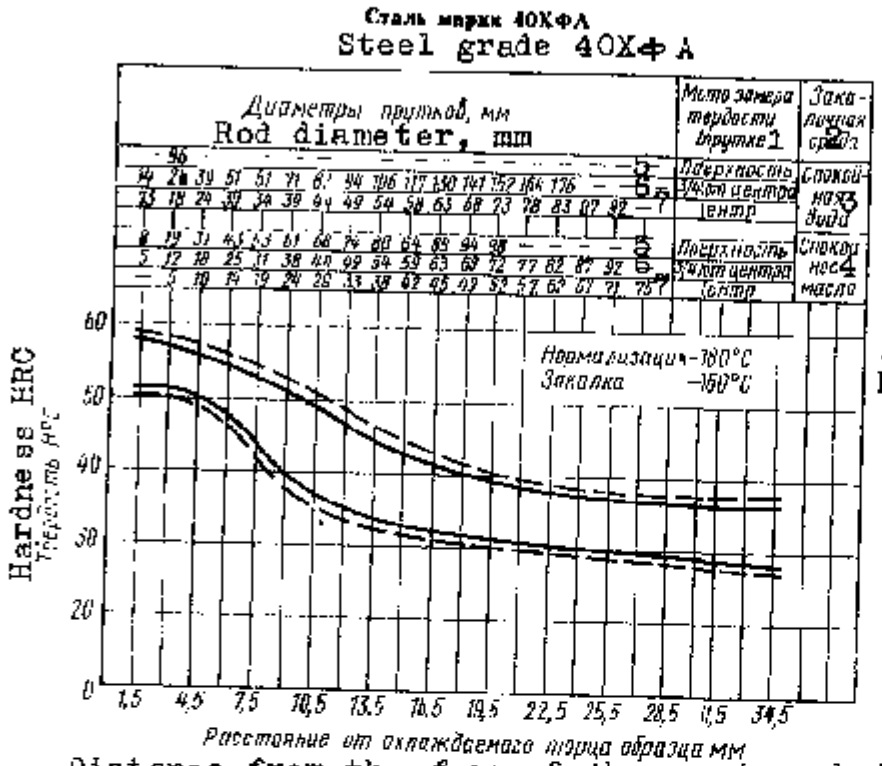
1. Place where hardness of rod is measured.
2. Hardening medium.
3. Placid water
4. Placid oil.
5. Surface.
6. 3/4 R. from centre
7. Centre.

Сталь марки 30ХМА
Steel grade 30ХМА



Drg. 15

1. Place where hardness of rod is measured.
2. Hardening medium.
3. Placid water
4. Placid oil.
5. Surface.
6. 3/4 R. from centre
7. Centre.



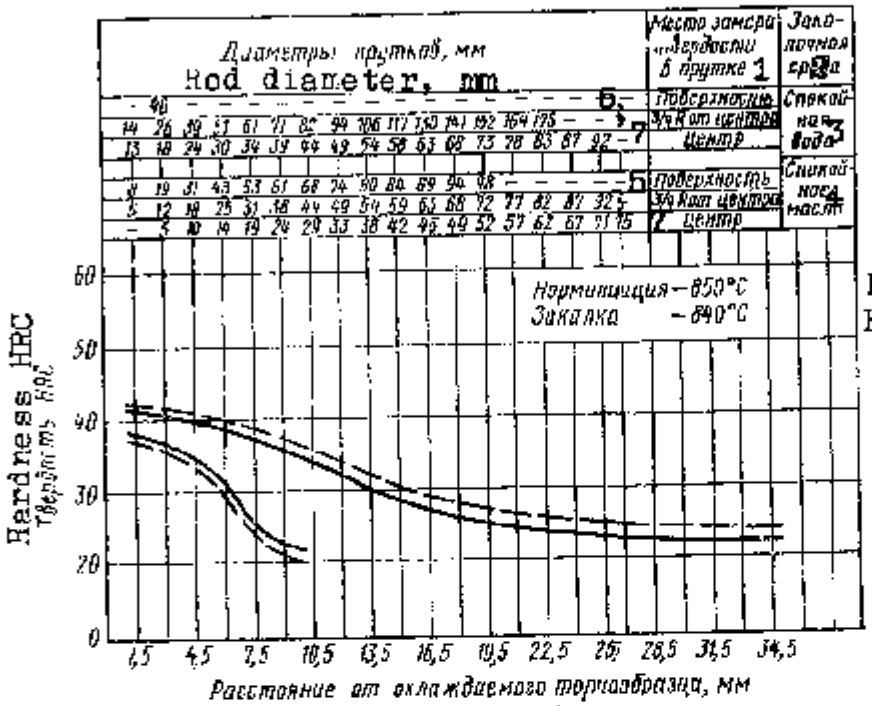
Черт 14

Drg. 14

Normalization–880°C
Hardening –860°C

1. Place where hardness of rod is measured.
2. Hardening medium.
3. Placid water.
4. Placid oil
5. Surface.
6. 3/4 R. from centre
7. Centre.

Сталь марки 12ХН3А
Steel grade 12ХН3А



Normalization – 860°C
Hardening – 840°C

Черт. 15

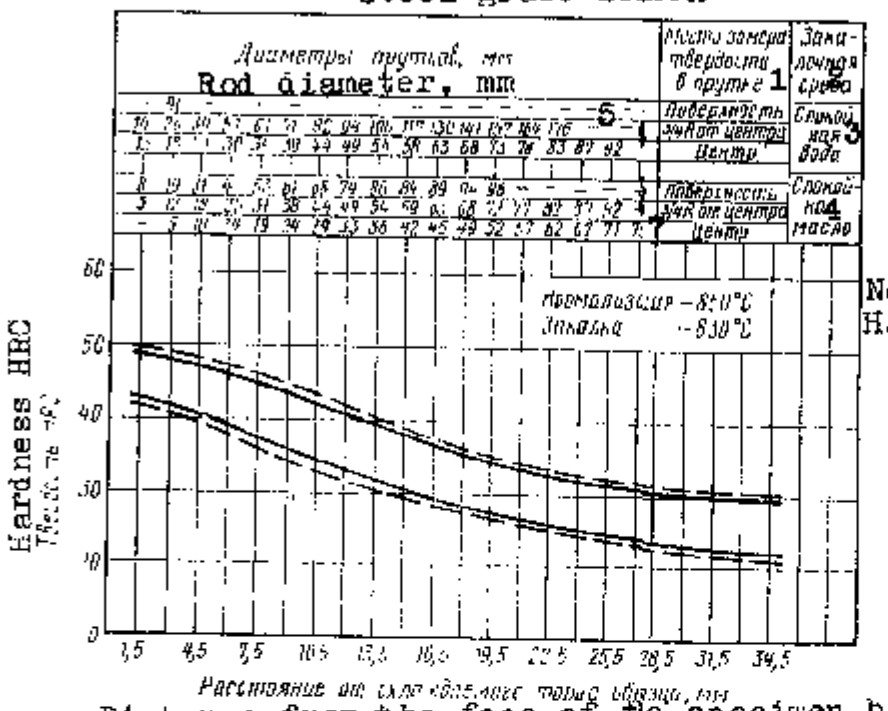
Distance from the face of the specimen being cooled, mm

Drg. 15

1. Place where hardness of rod is measured.
2. Hardening medium.
3. Placid water.
4. Placid oil
5. Surface.
6. 3/4 R. from centre
7. Centre.

Сталь марки 20ХН3А

Steel grade 20H3A



Normalization-850°C
Hardening -830°C

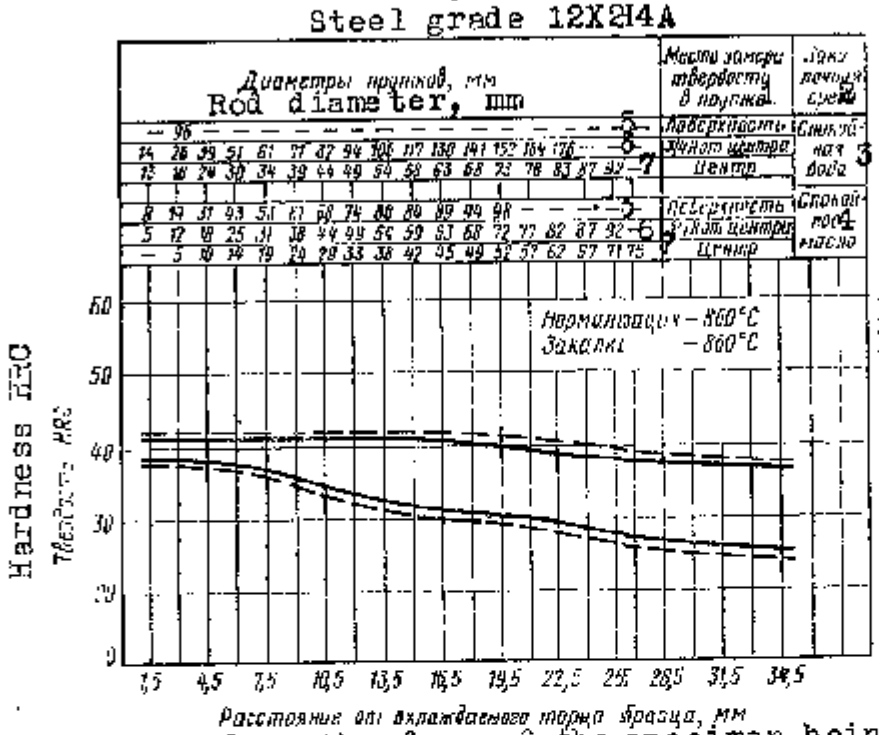
Черт. 16

Drg. 16

1. Place where hardness of rod is measured.
2. Hardening medium.
3. Placid water.
4. Placid oil
5. Surface.
6. 3/4 R. from centre
7. Centre.

Сталь марки 12Х2Н4А

Steel grade 12Х2Н4А

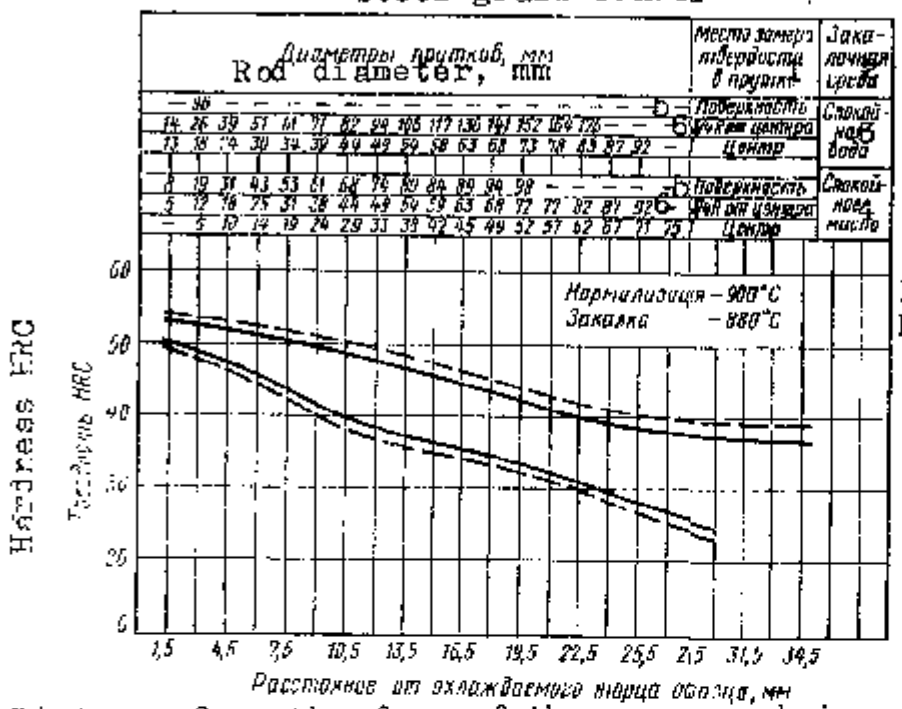


Normalization – 860°C
Hardening – 860°C

Черт. 17
Drg. 17

1. Place where hardness of rod is measured.
2. Hardening medium.
3. Placid water.
4. Placid oil
5. Surface.
6. 3/4 R. from centre
7. Centre.

Сталь марки 30ХГСА
Steel grade 30ХГСА



Hardness HRC

Normalization – 900°C
Hardening – 880°C

Distance from the face of the specimen being cooled, mm

Черт. 18

Drg. 13

1. Place where hardness of rod is measured.
2. Hardening medium.
3. Placid water.
4. Placid oil
5. Surface.
6. 3/4 R. from centre
7. Centre.

1. Reduced range
2. Grade-characteristic range

Annxure 2

Parameters of grade-characteristic range and reduced range

(Variation limits in hardness HRC along the length of the endwise hardened specimen)

Distance from the end, mm	Hardness for hardenability range HRC															
	1		2		1		2		1		2		1		2	
	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
	Steel grades															
	15X				20X				30X				35X			
1,5	42	35,5	43	34,5	46	39	47,5	37,0	51,5	47,5	53,0	46,5	52,0	45,0	54,0	43
3,0	41	32,5	43	30	43,5	34	45,0	32,0	50,0	44,0	52,0	42,5	52,0	43,0	53,0	41
4,5	38	25,5	41	23	40	29,5	42,5	27,0	48,0	40,0	50,0	38,5	50,5	41,0	52,5	39
6,0	34	—	37	—	36,5	26	38,5	22,5	45,5	37,0	48,0	35,0	49,5	37,0	52,0	35
7,5	28,5	—	31	—	32,5	22	34,0	20,0	43,5	33,5	45,0	32,0	47,0	33,0	50,0	30
9,0	25,5	—	27	—	29,5	—	30,5	—	39,5	31,0	41,0	29,0	45,0	29,0	47,0	27
10,5	22	—	24	—	26,5	—	25,0	—	36,0	28,5	37,5	26,5	42,0	28,0	44,0	26
12,0	20,5	—	22,5	—	24,5	—	26,5	—	33,0	26,5	34,5	24,5	39,5	25,5	42,0	24
13,5	—	—	21	—	23	—	25,0	—	30,5	24,5	32,0	23,0	37,0	23,0	39,0	21
15,0	—	—	20	—	22	—	24,0	—	29,0	23,0	30,0	22,0	36,0	22,0	37,0	20
16,5	—	—	—	—	21,5	—	23,5	—	27,5	—	28,5	—	34,0	21,0	35,0	19
18,0	—	—	—	—	21	—	22,5	—	26,5	—	27,5	—	33,0	20,0	34,5	18
19,5	—	—	—	—	20	—	22,0	—	26,0	—	27,0	—	—	—	—	—
21,0	—	—	—	—	—	—	21,5	—	25,0	—	26,5	—	—	—	—	—
24,0	—	—	—	—	—	—	—	—	24,0	—	25,0	—	—	—	—	—
27,0	—	—	—	—	—	—	—	—	22,5	—	23,5	—	—	—	—	—
30,0	—	—	—	—	—	—	—	—	21,0	—	22,0	—	—	—	—	—
33,0	—	—	—	—	—	—	—	—	19,5	—	20,5	—	—	—	—	—
36,0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
39,0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

1. Reduced range

2. Grade-characteristic range

Contd.

Distance from the end, mm	Hardness for hardenability range HRC															
	1		2		1		2		1		2		1		2	
	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
	Steel grades															
	40X				45X				18ХГТ				30ХГТ			
1,5	53,5	51	59,5	49	58	54	59	53	48	41	49	40	50,5	43,5	52	41,5
3,0	58	49,5	59	48	57,5	52,5	58,5	51,5	46	39,5	48	38	49,5	42,5	51	40,5
4,5	57	47,5	58	46,5	56,5	51	57,5	50	45	36	46	35	48,5	40,5	50	39
6,0	55,5	45	56,5	43,5	56	49,5	57	48	43	33	44,5	31	47,5	38,5	49	37
7,5	53,5	40,5	56	38	54,5	47,5	56	46	41	30	43	28	46,5	36,5	48	35
9,0	52,5	39	54	36,5	53	46,5	54	43,5	39,5	28	41	25,5	44,5	34,5	46,5	32,5
10,5	50,5	36,5	52,5	33,5	51,5	42,5	53	41	38	26,5	39,5	24	43	32,5	44,5	30,5
12,0	48	34	51	31	49,5	40	51,5	38	36,5	25	38	22,5	41,5	30,5	43	28,5
13,5	46	32,5	49	29,5	47,5	37,5	49,5	36	35,5	24	36,5	21,5	40	29	41,5	27
15,0	46,5	30,5	48	28	46	35	48	33	34	23	36	21	38	28	40	26
16,5	42,5	29,5	44,5	26,5	44	34	45,5	32,5	33	8	34,5	—	37	26,5	38,5	24
18,0	41	28	42,5	26	42	32	43,5	31	32	—	33,5	—	36	25	37,5	23
19,5	40,5	27	41	25	40,5	31	42	29,5	31	—	33	—	35	24	36,5	22
21,0	38,5	26,5	39,5	24	39	29,5	40,5	28,5	30,5	—	32	—	34	23	36	21
24,0	36,5	24,5	38	22,5	36	28	38	26,5	29	—	31	—	32	—	34	—
27,0	35	23	36,5	21,5	35	26,5	36	25	27,5	—	29,5	—	30,5	—	32,5	—
30,0	34	22	36	20	32,5	25,5	34	24	26,5	—	29	—	29,5	—	31,5	—
33,0	—	—	—	—	32,5	24	33	22,5	26	—	28	—	28,5	—	30,5	—
36,0	—	—	—	—	31	23	32,5	21,5	—	—	—	—	—	—	—	—
39,0	—	—	—	—	31	21,5	32,5	20,5	—	—	—	—	—	—	—	—

1. Reduced range

2. Grade-characteristic range

Contd.

Distance from the end, mm	Hardness for hardenability range HRC															
	1		2		1		2		1		2		1		2	
	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
	Steel grades															
	20ХГР				27ХГР				25ХГМ				ЖХМА			
1,5	44,5	37,5	46,0	36,0	50,5	45,0	51,5	44,0	50,0	44,0	51,0	43,0	52,0	49,0	53,0	48,0
3,0	44,0	37,0	45,5	35,5	50,5	45,0	51,5	44,0	49,0	42,5	50,0	41,5	51,0	47,5	52,0	46,5
4,5	43,5	36,5	45,0	35,0	50,0	44,5	51,0	43,5	48,0	41,0	49,0	40,0	50,0	46,0	51,0	44,5
6,0	43,0	33,5	44,5	33,5	50,0	44,5	51,0	43,5	47,0	39,0	48,0	38,0	48,5	43,5	49,5	42,0
7,5	42,5	33,5	44,0	32,0	49,0	43,5	50,5	42,5	46,0	37,5	47,5	36,0	47,0	40,0	48,0	39,0
9,0	41,0	32,0	43,0	30,0	48,5	43,5	50,0	42,0	45,0	36,5	46,5	35,0	45,0	37,0	46,5	35,5
10,5	40,0	30,0	42,5	27,5	48,0	43,0	49,5	41,5	44,0	35,5	45,5	34,0	43,5	34,5	45,0	33,5
12,0	39,0	27,5	41,5	25,0	47,5	41,5	49,0	40,0	43,0	34,5	45,0	33,0	41,5	33,0	43,0	31,5
13,5	37,5	25,5	40,0	23,0	47,0	40,0	48,5	38,5	42,5	33,5	44,0	32,0	39,0	31,5	40,5	30,0
15,0	37,0	24,0	39,0	22,0	46,5	39,0	48,0	37,5	42,0	33,0	43,0	30,5	36,5	29,5	38,0	26,0
16,5	35,0	—	37,0	—	46,0	36,5	47,5	35,0	41,0	31,5	42,5	29,5	35,5	29,5	37,0	27,0
18,0	34,0	—	36,5	—	45,0	35,5	46,5	33,0	40,5	31,0	42,0	28,5	34,5	27,5	36,0	26,0
19,5	33,0	—	34,0	—	44,0	34,0	46,0	32,0	39,5	30,0	41,0	27,5	33,5	26,5	35,0	25,0
21,0	31,5	—	33,0	—	43,0	32,0	44,5	30,0	38,5	29,0	40,5	26,5	32,5	25,5	34,0	24,5
24,0	29,5	—	31,0	—	41,5	29,0	42,5	27,0	37,5	27,0	39,5	25,0	31,0	24,0	32,5	22,0
27,0	28,0	—	29,5	—	40,0	26,5	41,0	25,0	36,5	26,0	38,5	24,5	30,0	22,0	32,0	20,5
30,0	26,5	—	28,5	—	38,0	24,0	39,0	23,0	35,5	25,0	37,5	23,5	29,0	—	31,0	—
33,0	25,5	—	27,5	—	36,0	22,5	37,5	21,5	34,5	24,0	36,0	22,5	28,0	—	30,0	—
36,0	25,0	—	27,0	—	34,0	21,5	35,0	20,0	33,5	22,5	35,0	21,0	—	—	—	—

1. Reduced range

2. Grade-characteristic range

Contd.

Distance from the end, mm	Hardness for hardenability range HRC											
	1		2		1		2		1		2	
	max	min	max	min	max	min	max	min	max	min	max	min
	Steel grades											
	38XC				40X				12XH3A			
1.5	55	48	56	46,5	58	51,5	59,5	50	41	38	41,5	37
3.0	55	47,5	56	45,5	57	51,5	58,5	50	40,5	35,5	41,5	35,5
4.5	54,5	46,5	56	45	56	50,5	57,5	49	39,5	34,5	40,5	33
6,0	54	45,5	55,5	44	54,5	48	56,5	46,5	38,5	31	39,5	29,5
7,5	53,5	44,5	55	43	53,5	42,5	55	42	36,5	25,5	39	23
9,0	53	43,5	54,5	41,5	51	39,5	53	38	35,5	22,5	37	21
10,5	52,5	42	54	40	49	37	51	35	34	—	35,5	—
12,0	52	40,5	53,5	38,5	47,5	35	49	33,5	32	—	33,5	—
13,5	51	39	53	37	44,5	34	46,5	32,5	30	—	31,5	—
15,0	50	38	52	35	43,5	33,5	45	32	28,5	—	30	—
16,5	49	36,5	51	34,5	41,5	32,5	43	31	27	—	29	—
18,0	48	35,5	50	34	40,5	32	41,5	30,5	26	—	28	—
19,5	47,5	35	49,5	33	39	31,5	40,5	30	25	—	27	—
21,0	46,5	34,5	49	32,5	38,5	31	39,5	29,5	24,5	—	26,5	—
24,0	45	33	47,5	31	37,5	30	38,5	29	23,5	—	25,5	—
27,0	44	32,5	46,5	30,5	36,5	29,5	37,5	28,5	23	—	24,5	—
30,0	43	32	45	30	36,5	29,5	38	28	22,5	—	24	—
33,0	42,5	29	45	27	36,5	28,5	37,5	27,5	22,5	—	24	—
36,0	42	25	44,5	23	36,5	28	37,5	27	—	—	—	—
39,0	41	22	44	20	36,5	25,5	37,5	25	—	—	—	—
42,0	—	—	—	—	36,5	23	37,5	22,5	—	—	—	—
45,0	—	—	—	—	36,5	21	37,5	20	—	—	—	—
48,0	—	—	—	—	—	—	—	—	—	—	—	—

1. Reduced range

2. Grade-characteristic range

Contd.

Distance from the end, mm	Hardness or hardenability range HR.											
	1		2		1		2		1		2	
	max	min	max	min	max	min	max	min	max	min	max	min
	Steel grades											
	20ХН3А				12Х2Н4А				30ХГСА			
1,5	49	43	49,5	41,5	41,5	37,5	42	37	53	50	54	49
3,0	48	41 5	49	40,5	41,5	36,5	42	36	52	49	53	47,5
4,5	47,5	40,5	48,5	39,5	41,5	36,5	42	36	51,5	47	52	46
6,0	46,5	39	47,5	37,5	41,5	36,5	42	36	50,5	45,5	51,5	44,5
7,5	44,5	37,5	46	36	41,5	37	42	36	50	44	51	43
9,0	43,5	35,5	44,5	34	41,5	35	42	34	49,5	41,5	51	40
10,5	42	33	43	32,5	41,5	33,5	42	32,5	48,5	40,5	50	38
12,0	40	32,5	41,5	31	41,5	33	42	32	47,5	38	49,5	36,5
13,5	39	31 5	40	30	41,5	32,5	42	31,5	46,5	37	48,5	35,5
15,0	37,5	30,5	39	29	41,5	31	42	30	45,5	36,5	47	35
16,5	36	29,5	37,5	27,5	41,5	30,5	42	29,5	44,5	35,5	46	34,5
18,0	35	28	36	27	40	30	41	29	43	34,5	45	33 5
19,5	34	27	35	26	39,5	30	41	29	42	33,5	44	32
21,0	33	26,5	34	25,5	39	29,5	40,5	28,5	41	32	43	31
27,0	30	24,5	31,5	23,5	38	27	40	26	38	27,5	40	25
30,0	30	23	31	22	37,5	27,5	39	26	37	25	39	23
33,0	29,5	22,5	30,5	21	36	26	38	24	37	22	39	20,5
36,0	29	22,5	30	21	—	—	—	—	—	—	—	—
39,0	28	21,5	29	20	—	—	—	—	—	—	—	—
42,0	28	21,5	29	20	—	—	—	—	—	—	—	—
45,0	28	21,5	29	20	—	—	—	—	—	—	—	—
48,0	27	21,5	28	20	—	—	—	—	—	—	—	—

Annexure 3
Recommended

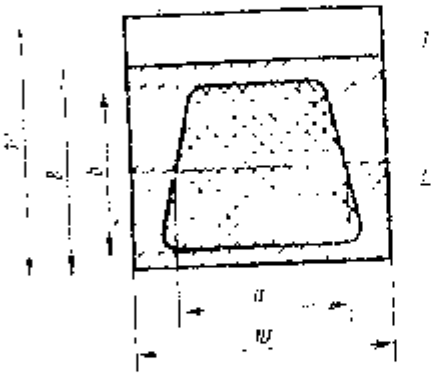
A METHOD FOR ESTIMATING THE DUCTILE COMPONENT IN THE FRACTURE OF IMPACT SPECIMENS

(FOR STEEL BEING IMPROVED)

1. The proportion of ductile component in the fracture of impact specimens is an index of the resistance of steel to brittle failure.

The brittle component in the fracture of an impact specimen of section 8x10 mm takes the form of a trapezium (drg.1). The area of this trapezium F_1 increases in proportion to the brittle component (drg.2).

SCHEMATIC OF IMPACT FRACTURE



Drg.1

1. Fracture area taken up by the brittle component;
2. Fracture area taken up by ductile component.

As a rule, the ductile component surrounds the brittle component. The area F_1 taken up by the brittle component is the product of the centre line "a" of the trapezium and the height "b" (see drg.1). The ration of this area to the total area of the fracture F (80 mm^2) is the proportion of the brittle component of the fracture (X) as a percentage:

$$X = \frac{F_1}{F} 100,$$

Correspondingly, the ductile component (B) as a percentage equals

$$B = (100-X).$$

2. The parameters "a" and "b" of the area representing the brittle component are measured with a scale of 0.5 mm accuracy which should only produce an error not exceeding 5 %. Knowing the parameters "a" and "b" the percentage of the component can be found from the Table below.