The present technical delivery conditions are harmonized with the requirements specified in ASTM A29/A29M, ASTM A 322, ASTM A 576, ASTM A 304 and cover technical requirements for metal products.

The present technical delivery conditions are an integral part of the contract with customers abroad.

1. SCOPE

1.1. Hot-rolled round bars 0,7874-11,0236 inches (20-280mm) in diameter with peeled/ turned surface.
1.2. Hot-rolled round bars 0,3149-5,1181 inches (8-130mm) in diameter without peeling/ turning.
1.3. Forged round bars 2,9527-21,6535 inches (75-550mm) in diameter with peeled/ turned surface.
1.4. Round bars 0,1181-1,9685 inches (3,00-50,00mm) in diameter with ground and polished surface.
1.5. Hot-rolled and forged round bars 0,4724-7,8740 inches (12,00-200,00mm) in diameter with ground and polished surface produced on the *Landgraf* automatic line.
1.6. Hot-rolled square billet 1,7716-9,8425 inches (45-250mm) in square side with ground surface.
1.7. Blooms 7,4803-11,0236 inches (190-280mm) in square side with ground surface.
1.8. Hot-rolled square bars 0,3149-3,9370 inches (8-100mm) in square side.
1.9. Forged square bars 3,1496-17,7165 inches (80-450mm) in square side.
1.10. Rectangular forgings (forged flats) 1,1811-11,8110 x 3,1496-31,4960 inches (30-300 x 80-800mm) in cross-section.
1.11. Round bars 0,750 inches (19,050mm) to 21,500 inches (546,100mm) delivered with machining allowance at site.

2. MANUFACTURE

Steel is melted in electric arc furnaces with further vacuum degassing or produced by ESR-method. Then ingots are subjected to hot working on rolling mills, presses, hammers or radial forging machines.

Melting method shall be agreed upon in the specification.

Ground and polished surface for bars 3,00-50,00mm in diameter can be achieved in any process of rolling skin removing at the manufacturer's option. Hot-rolled and forged bars 12-200mm in diameter are ground and polished on the *Landgraf* automatic line.

3. STEEL GRADES

Steel grades and chemical composition of carbon structural and alloy structural steel according to ASTM A 29/A29M shall meet the requirements specified in Tables 1 and 2.

Steel grades and chemical composition of alloy structural steel according to ASTM A 304 shall meet the requirements specified in Table 3.

Table 1. Steel Grades and Chemical Composition of Carbon Structural Steel acc. to ASTM A29/A29M

Steel Grade		Weight Percent by Element, %										
ASTM	GOST	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Al	Other Elements
1018-MOD	17	0,15 0,18	0,15 0,35	0,60 0,90	0,040 max	0,040 max	0,20 max	0,06 max	0,25 max	0,30 max	0,020 0,050	-
1018	18	0,15 0,20	0,15 0,35	0,60 0,90	0,040 max	0,040 max	0,20 max	0,06 max	0,25 max	0,30 max	0,020 0,050	-
1020	20	0,18 0,23	0,15 0,35	0,30 0,60	0,040 max	0,040 max	0,20 max	0,06 max	0,25 max	0,30 max	0,020 0,050	-
1022	22	0,18 0,23	0,15 0,35	0,70 1,00	0,040 max	0,040 max	0,20 max	0,06 max	0,25 max	0,30 max	0,020 0,050	-
1030	30	0,28 0,34	0,15 0,35	0,60 0,90	0,040 max	0,040 max	0,20 max	0,06 max	0,25 max	0,30 max	0,020 0,050	-
1030-MOD	31	0,30 0,34	0,15 0,35	0,60 0,90	0,040 max	0,040 max	0,20 max	0,06 max	0,25 max	0,30 max	0,020 0,050	-
1035	35	0,32 0,38	0,15 0,35	0,60 0,90	0,040 max	0,040 max	0,20 max	0,06 max	0,25 max	0,30 max	0,020 0,050	-
1040	40	0,37 0,44	0,15 0,35	0,60 0,90	0,040 max	0,040 max	0,20 max	0,06 max	0,25 max	0,30 max	0,020 0,050	-
1040/1042	41	0,40 0,44	0,15 0,35	0,60 0,90	0,040 max	0,040 max	0,20 max	0,06 max	0,25 max	0,30 max	0,020 0,050	-
1042	42	0,40 0,47	0,15 0,35	0,60 0,90	0,040 max	0,040 max	0,20 max	0,06 max	0,25 max	0,30 max	0,020 0,050	-
1045	45	0,43 0,50	0,15 0,35	0,60 0,90	0,040 max	0,040 max	0,20 max	0,06 max	0,25 max	0,30 max	0,020 0,050	-
1050	50	0,48 0,55	0,15 0,35	0,60 0,90	0,040 max	0,040 max	0,20 max	0,06 max	0,25 max	0,30 max	0,020 0,050	-
1055	55	0,50 0,60	0,15 0,35	0,60 0,90	0,040 max	0,040 max	0,20 max	0,06 max	0,25 max	0,30 max	0,020 0,050	-
1060	60	0,55 0,65	0,15 0,35	0,60 0,90	0,040 max	0,040 max	0,20 max	0,06 max	0,25 max	0,30 max	0,020 0,050	-

Notes:

1. Upon agreement between parties stated in the specification, all steel grades can be produced with Sulfur content 0,020-0,040%. In this case grade designation according to GOST contains the letter «У1» added in hyphen.

2. By agreement between purchaser and supplier stated in the specification, all steel grades can be produced with Sulfur content 0,020-0,035%. In this case steel grade designation according to GOST shall contain the letter «У2» added in hyphen.

3. By agreement between purchaser and supplier stated in the specification, all steel grades can be produced with Sulfur content 0,020% maximum and Phosphorus content 0,025% maximum. In this case steel grade designation according to GOST shall contain the letter «А».

4. On the customer request stated in the specification steel grade designations «ESMS-1018», «ESMS-1045» correspondingly can be stated instead of steel grade designations according to ASTM «1018», «1045».

5. Weight percent by residual elements not stated in Table 1 shall not exceed the following values: W-0,15%, V-0,05%, Sn+Ti+As-0,050%.

6. For steel produced by ESR-method steel grade designations according to ASTM shall contain «ESR» indication and steel grade designations according to GOST shall contain the letter «Ш» added in hyphen. Sulfur content shall not exceed 0,015% and Phosphorous content shall not exceed 0,020% in the electro-slag remelted steel grades.

Table 2 . Steel Grades and Chemical Composition of Alloy Structural Steel acc. to ASTM A29/A29M

Steel Grade		Weight Percent by Element, %										
ASTM	GOST	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Al	Other Elements
4130	30ХМ	0,28 0,33	0,15 0,35	0,40 0,60	0,035 max	0,040 max	0,80 1,10	0,15 0,25	0,25 max	0,30 max	0,020 0,050	-
4140	40ХГМ	0,38 0,43	0,15 0,35	0,75 1,00	0,035 max	0,040 max	0,80 1,10	0,15 0,25	0,25 max	0,30 max	0,020 0,050	-
4140-MOD	41ХГМ	0,40 0,43	0,15 0,35	0,75 1,00	0,035 max	0,040 max	0,80 1,10	0,15 0,25	0,20 max	0,25 max	0,020 0,050	-
4142	42ХГМ	0,40 0,45	0,15 0,35	0,75 1,00	0,035 max	0,040 max	0,80 1,10	0,15 0,25	0,25 max	0,30 max	0,020 0,050	-
4145	45ХГМ	0,43 0,48	0,15 0,35	0,75 1,00	0,035 max	0,040 max	0,80 1,10	0,15 0,25	0,25 max	0,30 max	0,020 0,050	V≤0,03
4150	50ХГМ	0,48 0,53	0,15 0,35	0,75 1,00	0,035 max	0,040 max	0,80 1,10	0,15 0,25	0,25 max	0,30 max	0,020 0,050	-
4340	40ХГН2М	0,38 0,43	0,15 0,35	0,60 0,80	0,035 max	0,040 max	0,70 0,90	0,20 0,30	1,65 2,00	0,30 max	0,020 0,050	-
6150	50ХГФ	0,48 0,53	0,15 0,35	0,70 0,90	0,035 max	0,040 max	0,80 1,10	0,06 max	0,25 max	0,30 max	0,020 0,050	V:0,15-0,25
8620	20ХГНМ	0,18 0,23	0,15 0,35	0,70 0,90	0,035 max	0,040 max	0,40 0,60	0,15 0,25	0,40 0,70	0,30 max	0,020 0,050	-

Notes:

1. By agreement between purchaser and supplier stated in the specification, all steel grades can be produced with Sulfur content 0,020-0,040%. In this case steel grade designation according to GOST shall contain the letter «У1» in hyphen.

2. By agreement between purchaser and supplier stated in the specification, all steel grades can be produced with Sulfur content 0,020-0,035%. In this case steel grade designation according to GOST shall contain the letter «У2» added in hyphen.

3. By agreement between purchaser and supplier stated in the specification, all steel grades can be produced with Sulfur content 0,020% max and with Phosphorous content 0,025% max. In this case steel grade designation according to GOST shall contain the letter «А».

4. On the customer request stated in the specification steel grade designations «ESMS-4140» or «4140CaLPA» and «ESMS-8620» correspondingly shall be stated instead of steel grade designations according to ASTM «4140», «8620».

5. Weight percent by residual elements not stated in Table 2 shall not exceed the following values: W-0,20%, V-0,05%, Nb-0,02%, Sn+Ti+As-0,050%.

6. For steel produced by ESR-method steel grade designations according to ASTM shall contain «ESR» indication and steel grade designations according to GOST shall contain the letter «Ш». Sulfur content shall not exceed 0,015% and Phosphorous content shall not exceed 0,020% in the electro-slag remelted steel grades.

Table 3. Steel Grades and Chemical Composition of Alloy Structural Steel acc. to ASTM A304

Steel Grade		Weight Percent by Element, %										
ASTM	GOST	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Al	Other Elements
4130H	30ХМ-У	0,27 0,33	0,15 0,35	0,30 0,70	0,025 max	0,025 max	0,75 1,20	0,15 0,25	0,25 max	0,30 max	0,020 0,050	-
4140H	40ХГМ-У	0,37 0,44	0,15 0,35	0,65 1,10	0,025 max	0,025 max	0,75 1,20	0,15 0,25	0,25 max	0,30 max	0,020 0,050	-
4142H	42ХГМ-У	0,39 0,46	0,15 0,35	0,65 1,10	0,025 max	0,025 max	0,75 1,20	0,15 0,25	0,25 max	0,30 max	0,020 0,050	-
4145H	45ХГМ-У	0,42 0,49	0,15 0,35	0,65 1,10	0,025 max	0,025 max	0,75 1,20	0,15 0,25	0,25 max	0,30 max	0,020 0,050	-
4150H	50ХГМ-У	0,47 0,54	0,15 0,35	0,75 1,10	0,025 max	0,025 max	0,80 1,10	0,15 0,25	0,25 max	0,30 max	0,020 0,050	-
4340H	40ХГН2М-У	0,37 0,44	0,15 0,35	0,55 0,90	0,025 max	0,025 max	0,65 0,95	0,20 0,30	1,55 2,00	0,30 max	0,020 0,050	-
6150H	50ХГФ-У	0,47 0,54	0,15 0,35	0,60 1,00	0,025 max	0,025 max	0,75 1,20	0,06 max	0,25 max	0,30 max	0,020 0,050	V:0,15-0,25
8620H	20ХГНМ-У	0,17 0,23	0,15 0,35	0,60 0,95	0,025 max	0,025 max	0,35 0,65	0,15 0,25	0,35 0,75	0,30 max	0,020 0,050	-

Notes:

1. Weight percent by residual elements not stated in Table 3 shall not exceed the following values: W-0,15%, V-0,05%, Ti-0,03%, Nb-0,02%.

2. For steel produced by ESR-method steel grade designations according to ASTM shall contain «ESR» indication and steel grade designations according to GOST shall contain the letter «Ш» added in hyphen. Sulfur content shall not exceed 0,015% and Phosphorous content shall not exceed 0,020% in the electro-slag remelted steel grades.

In finished product chemical composition variations for carbon structural steel shall not exceed the values shown in Table 4, and for alloy structural steel shall not exceed the values shown in Table 5.

Table 4. Permissible Variations in Chemical Composition for Finished Product of Carbon Structural Steel

Chemical Element	Weight Percent by Element,%	Permissible Variations,%
Carbon	≤0,25 >0,25≤0,55 >0,55	±0,02 ±0,03 ±0,04
Silicon	0,15-0,35	±0,02
Manganese	≤0,90 >0,90	±0,03 ±0,04
Phosphor	≤0,040	+0,005
Sulfur	≤0,040 0,020-0,040	+0,005 ±0,005
Aluminum	0,020-0,050	±0,005

Table 5. Permissible Variations in Chemical Composition for Finished Product of Alloy Structural Steel

Chemical Element	Weight Percent by Element,%	Permissible Variations,%
Carbon	≤0,30 >0,30≤0,75	±0,01 ±0,02
Silicon	0,15-0,35	±0,02
Manganese	≤0,90 >0,90≤2,10	±0,03 ±0,04
Phosphor	≤0,035	+0,005
Sulfur	≤0,040 0,020-0,040	+0,005 ±0,005
Chromium	≤0,90 >0,90≤2,10	±0,03 ±0,05
Molybdenum	≤0,20 >0,20≤0,40	±0,01 ±0,02
Nickel	≤1,00 >1,00≤2,00	±0,03 ±0,05
Vanadium	>0,10≤0,25	±0,02
Aluminum	0,020-0,050	±0,005

4. PRODUCT RANGE

Metal products are to be produced as hot-rolled round bars and hot-rolled square bars, round bars with ground and polished surface, round, square and rectangular forgings.

Shape, size and permissible deviations of metal products shall correspond to the requirements of sections 4.1-4.11.

4.1 Hot-rolled round bars 0,7874-11,0236 inches (20-280mm) in diameter with peeled/ turned surface

Bar diameter and the utmost deviations from it shall conform to the requirements specified in Table 6.

Table 6. Diameter and Utmost Deviations from it for Hot-Rolled Round Bars with Peeled/ Turned Surface

Diameter		Utmost Deviations, mm	
inches	mm	lot 1	lot 2
0,7874 to 0,8661	20,00 to 22,00	±0,20	+0,40/–0,0
over 0,8661 to 0,9842	over 22,00 to 25,00	±0,23	+0,46/–0,0
over 0,9842 to 1,1023	over 25,00 to 28,00	±0,25	+0,50/–0,0
over 1,1023 to 1,2401	over 28,00 to 31,50	±0,28	+0,56/–0,0
over 1,2401 to 1,8897	over 31,50 to 48,00	±0,30	+0,60/–0,0
over 1,8897 to 2,4803	over 48,00 to 63,00	±0,40	+0,80/–0,0
over 2,4803 to 3,5433	over 63,00 to 90,00	±0,60	+1,20/–0,0
over 3,5433 to 4,5275	over 90,00 to 115,00	±0,70	+1,40/–0,0
over 4,5275 to 6,1023	over 115,00 to 155,00	±1,00	+2,00/–0,0
over 6,1023 to 7,0866	over 155,00 to 180,00	±1,25	+2,50/–0,0
over 7,0866 to 11,0236	over 180,00 to 280,00	±1,5	+3,00/-0,0

Note: lot number shall be stated in the specification.

Out-of-round shall not exceed 50% of the total utmost deviations from diameter.

Straightness deviations of the bars shall be 2,0mm maximum per 1m of length.

Bar ends shall be straight cut. Burrs and center holes are not allowed.

Inclination from the cut shall not exceed 0,1 of bar diameter.

Bars shall be 3, 0 - 6,0m in production length with utmost deviations from the length ±100mm. Actual length shall be stated in the specification.

4.2 Hot-rolled round bars 0,3149-5,1181 inches (8-130mm) without peeling/ turning

Bar diameter and utmost deviations from it shall correspond to the requirements specified in Table 7.

Table 7. Diameter and Utmost Deviations from it for Hot-Rolled Round Bars without Peeling/ Turning

Diameter, mm		Utmost Deviations, mm	
inches	mm	lot 1	lot 2
0,3149	8	+0,3/–0,5	+0,8/–0,0
0,3543	9		
0,3937	10		
0,4330	11		
0,4724	12		
0,5118	13		
0,5511	14		
0,5905	15		
0,6299	16		
0,6692	17		
0,7086	18		
0,7480	19		
0,7874	20	+0,4/–0,5	+0,9/–0,0
0,8267	21		
0,8661	22		
0,9055	23		
0,9448	24		
0,9842	25		

Table 7 continued

Diameter, mm	Utmost Deviations, mm

inches	mm	lot 1	lot 2
1,0236	26	+0,3/–0,7	+1,0/–0,0
1,0629	27		
1,1023	28		
1,1417	29		
1,1811	30		
1,2204	31	+0,4/–0,7	+1,1/–0,0
1,2598	32		
1,2992	33		
1,3385	34		
1,3779	35		
1,4173	36		
1,4566	37		
1,4960	38		
1,5354	39	+0,4/–0,7	+1,1/–0,0
1,5748	40	+0,4/–0,7	+1,1/–0,0
1,7322	44	+0,4/–0,7	—
1,7716	45	+0,4/–0,7	+1,1/–0,0
1,8110	46	+0,4/–0,7	+1,1/–0,0
1,8897	48	+0,4/–0,7	+1,1/–0,0
1,9685	50	+0,4/–1,0	+1,4/–0,0
2,0472	52	+0,4/–1,0	+1,4/–0,0
2,0866	53	—	+1,4/–0,0
2,1653	55	+0,4/–1,0	+1,4/–0,0
2,2047	56	+0,4/–1,0	+1,4/–0,0
2,2834	58	+0,4/–1,0	—
2,3622	60	+0,5/–1,1	+1,6/–0,0
2,4409	62	+0,5/–1,1	—
2,4803	63	+0,5/–1,1	+1,6/–0,0
2,5590	65	+0,5/–1,1	+1,6/–0,0
2,6771	68	+0,5/–1,1	—
2,7559	70	+0,5/–1,1	+1,6/–0,0
2,8740	73	+0,5/–1,1	+1,6/–0,0
2,9527	75	+0,5/–1,1	+1,6/–0,0
3,0708	78	+0,5/–1,1	—
3,1496	80	+0,5/–1,3	+1,8/–0,0
3,2677	83	+0,5/–1,3	—
3,3464	85	+0,5/–1,3	+1,8/–0,0
3,4645	88	+0,5/–1,3	—
3,6614	93	+0,5/–1,3	—
3,5433	90	+0,5/–1,3	+1,8/–0,0
3,7401	95	+0,5/–1,3	+1,8/–0,0
3,8582	98	+0,5/–1,3	—
3,9370	100	+0,6/–1,7	+2,3/–0,0
4,0748	103,5	+0,6/–1,7	—
4,1338	105	+0,6/–1,7	+2,3/–0,0
4,2716	108,5	+0,6/–1,7	—
4,3307	110	+0,6/–1,7	+2,3/–0,0
4,4685	113,5	+0,6/–1,7	—
4,5275	115	+0,6/–1,7	+2,3/–0,0
4,6653	118,5	+0,6/–1,7	—
4,7244	120	+0,8/–2,0	+2,8/–0,0
4,8622	123,5	+0,8/–2,0	—
4,9212	125	+0,8/–2,0	+2,8/–0,0
5,0590	128,5	+0,8/–2,0	—
5,1181	130	+0,8/–2,0	+2,8/–0,0

Note: lot number shall be stated in the specification.

Out-of-round shall not exceed 50% of the total utmost deviations from diameter.
Straightness deviations of the bars shall be 2,0mm maximum per 1m of length.
Bar ends shall be straight cut and deburred.

Burrs and squeezed ends not exceeding the utmost plus deviations from diameter are permitted.

For bars 8-19mm in diameter inclination from the cut shall not exceed 2mm, and for bars 20-130mm in diameter it shall be 0,1 maximum of bar diameter.

Bars shall be 2,0 - 6,0m in production length with utmost deviations from the length ±100mm. Actual length is to be stated in the specification.

4.3 Forged round bars 2,9527-21,6535 inches (75-550mm) in diameter with peeled/ turned surface

Bar diameter and utmost deviations from it shall conform to the requirements specified in Table 8.

Table 8. Diameter and Utmost Deviations from it for Forged Round Bars with Peeled/ Turned Surface

Diameter		Utmost Deviations, mm
inches	mm	
2,9527-3,8188	75-97	+1,2/-0,0
3,8582-4,5275	98-115	+1,4/-0,0
4,5669-6,1023	116-155	+2,0/-0,0
6,1417-7,0866	156-180	+2,5/-0,0
7,1259-19,6850	181-500	+3,0/-0,0
19,7244-20,8661	501-530	+4,0/-0,0
20,9055-21,6535	531-550	+5,0/-0,0

Out-of-round shall not exceed the total utmost deviations from diameter.

Straightness deviations for forged bars with turned surface shall be 2,0mm maximum per 1m of length.

Bar ends shall be straight cut. Burrs and center holes are not allowed.

Inclination from the cut shall not exceed 0,1 of bar diameter. Steps on the bar ends are permitted if they do not exceed 3,0mmin height.

Bars shall be 2,0 -6,0m in production length with utmost deviations from the length ±100mm. Actual length is to be stated in the specification.

4.4 Round bars 0,1181-1,9685 inches (3,00-50,00mm) in diameter with ground and polished surface

Bar diameter and utmost deviations from it shall conform to the requirements specified in Table 9.

Table 9. Diameter and Utmost Deviations from it for Round Bars with Ground and Polished Surface

Diameter		Utmost Deviations from Diameter (for size tolerance), mm							
inches	mm	h9	k9	h10	k10	h11	k11	h12	k12
0,1181	3,00	-0,025	+0,025	-0,040	+0,040	-0,060	+0,060	-	-
over 0,1181 to 0,2362	over 3,00 to 6,00	-0,030	+0,030	-0,048	+0,048	-0,075	+0,075	-0,120	+0,120
over 0,2362 to 0,3937	over 6,00 to 10,00	-0,036	+0,036	-0,058	+0,058	-0,090	+0,090	-0,150	+0,150
over 0,3937 to 0,7086	over 10,00 to 18,00	-	-	-0,070	+0,070	-0,110	+0,110	-0,180	+0,180
over 0,7086 to 1,1811	over 18,00 to 30,00	-	-	-0,084	+0,084	-0,130	+0,130	-0,210	+0,210
over 1,1811 to 1,3385	over 30,00 to 34,00	-	-	-0,100	+0,100	-0,160	+0,160	-0,250	+0,250
over 1,3385 to 1,9685	over 34,00 to 50,00	-	-	-	-	-0,160	+0,160	-0,250	+0,250

For bars with ground and polished surface 3,00-10,00mm in diameter with size tolerance h9 (k9), over 10,00 to 34,00mm in diameter with size tolerance h10 (k10), over 34,00 to 50,00mm in diameter with size tolerance h11 (k11) it is permitted to deliver 20% of each item with size tolerance h10 (k10), h11 (k11), h12 (k12) correspondingly separately bundled. Bundle tag with indicated utmost deviations shall be additionally marked with a round 4-5mm in diameter in the right upper corner.

Out-of-round shall not exceed ½ of the utmost deviation from diameter.

Local straightness deviations shall not exceed 0,5mm per 1m of length for bars up to 30,00mm inclusive in diameter and 1,0mm per 1m of length for bars over 30,00mm in diameter.

Bar ends shall be straight cut without bending and burrs. Inclination from the cut shall be 0,1 maximum of bar diameter.

Bars up to 13,00mm in diameter shall be 2,0-3,0m in length, bars over 13,00mm in diameter shall be 4,0-5,5m in length with utmost deviations from the length +50/-0mm. It is permitted to agree the other bar length and the utmost deviations from it in the specification.

4.5 Hot-rolled or forged round bars 0,4724-7,8740 inches (12,00-200,00mm) in diameter with ground and polished surface produced on the *Landgraf* automatic line

Bar diameter and utmost deviations from it shall conform to the requirements specified in Table 10.

Table 10. Diameter and Utmost Deviations from it for Hot-Rolled or Forged Round Bars with Ground and Polished Surface Produced on the *Landgraf* Automatic Line

Diameter		Utmost Deviations from Diameter for Size Tolerances, mm					
inches	mm	h9	k9	h10	k10	h11	k11
0,4724 to 0,7086	12,00 to 18,00	-0,043	+0,043	-0,070	+0,070	-0,110	+0,110
over 0,7086 to 1,1811	over 18,00 to 30,00	-0,052	+0,052	-0,084	+0,084	-0,130	+0,130
over 1,1811 to 1,9685	over 30,00 to 50,00	-0,062	+0,062	-0,100	+0,100	-0,160	+0,160
over 1,9685 to 3,1496	over 50,00 to 80,00	-0,074	+0,074	-0,120	+0,120	-0,190	+0,190
over 3,1496 to 4,7244	over 80,00 to 120,00	-0,087	+0,087	-0,140	+0,140	-0,220	+0,220
over 4,7244 to 6,2992	over 120,00 to 160,00	-0,100	+0,100	-0,160	+0,160	-0,250	+0,250
over 6,2992 to 7,0866	over 160,00 to 180,00	-	-	-0,160	+0,160	-0,250	+0,250
over 7,0866 to 7,8740	over 180,00 to 200,00	-	-	-0,185	+0,185	-0,290	+0,290

Notes:

1. Size tolerance shall be stated in the specification.
2. By agreement between sides stated in the specification it is permitted to deliver 10% of bars with size tolerance h9 (k9), h10 (k10) of each item with size tolerance h10 (k10) и h11 (k11) correspondingly, separately bundled. Bundle tag with indicated utmost deviations shall be additionally marked with a round 4-5mm in diameter in the right upper corner.

Out-of-round (the difference between the maximal and minimal diameters measured at the same cross section) shall not exceed ½ of the utmost deviations from diameter.

Straightness deviations shall not exceed 0,5mm per 1m of length for bars up to 30mm inclusive in diameter and 1,0mm per 1m of length for bars over 30mm in diameter.

Bar ends shall be straight cut, turned or milled. Inclination from the cut shall be 0,1 maximum of bar diameter.

One end of bars up to 70,00mm in diameter shall be chamfered. It is permitted to chamfer both bar ends.

Bars shall be 3,0-6,0m in length with utmost deviations from the length +50/-0mm. Actual bar length can be agreed in the specification.

4.6 Hot-rolled square billet 1,7716-9,8425 inches (45-250mm) in square side with ground surface

Square billet dimensions and utmost deviations from them shall conform to the requirements specified in Table 11.

Table 11. Hot-Rolled Square Billet Sizes and Utmost Deviations from them

Billet Size		Corner Radius, mm	Utmost Deviations from Square Side, mm
inches	mm		
1,7716	45	7	±1,2
1,9685	50		
2,3622	60	9	±1,6
2,4803	63	7,5	±1,6

2,5590	65	9	±1,6
2,7559	70		
2,9527	75	12	±2,0
3,1496	80		
3,5433	90		
3,9370	100	15	±2,4
4,1338	105		
4,3307	110	18	±2,7
4,7244	120		
4,9212	125		
5,1181	130	21	±3,2
5,3149	135		
5,5118	140		
5,9055	150		
6,2992	160	25	±3,9
6,6929	170		
7,0866	180		
7,2834	185		
9,0551	230	35	±5,2
9,4488	240		
9,8425	250		

Note: corner radius is given for shaping pass setting and it is not checked on a billet.

Convexity, concavity and the difference between two opposite sides of the billet shall not exceed the total utmost deviations from the square side.

Difference between the diagonals at the same cross section shall not exceed 0,7 of the total utmost deviations from the square side.

Straightness deviations shall not exceed 5mm per 1m of length. Overall bow shall not exceed the permissible straightness deviation value multiplied by total length in meters.

Twisting shall not exceed 3 degree per 1 meter of length multiplied by length value in meters, but not more than 15 degrees.

Bar ends shall be straight cut. The inclination from the cut shall not exceed 8mm.

When shearing, squeezed ends are acceptable.

Bars shall be delivered with the production length 2,0 -6,0m with the utmost deviations from the length ±100mm.

Actual length can be agreed in the specification.

4.7 Blooms 7,4803-11,0236 inches (190-280mm) in bloom side with ground surface

Bloom sizes and utmost deviations from them shall conform to the requirements specified in Table 12.

Table 12. Bloom Sizes and Utmost Deviations from them

Bloom Side		Corner Radius, mm	Utmost Deviations from the Bloom Side, mm
inches	mm		
7,4803	190	25	±6,0
7,8740	200	30	±6,0
8,2677	210	30	±6,0
8,6614	220	35	±6,0
9,4488	240	35	±7,0
9,8425	250	35	±7,0
10,2362	260	40	±7,0

Table 12. Bloom Sizes and Utmost Deviations from them

Bloom Side			
10,6299	270	40	±8,0
11,0236	280	40	±8,0

Note: corner radius is given for shaping pass setting and is not controlled on a bloom.

Bloom sides shall be straight or concave.

Blooms with convexity of two opposite sides not exceeding permissible deviations from the bloom side are acceptable. The middle part of these bloom sides with width 1/3 min of bloom side shall be straight or concave.

Straightness deviations shall be 10mm maximum per 1m of length. Overall bow shall not exceed the permissible straightness deviation value multiplied by total length value in meters.

Twisting shall not exceed 4 degrees per 1 meter of length multiplied by length value in meters, but not more than 20 degrees.

Bloom ends shall be cut. Inclination from the cut shall not exceed 0,1 of the bloom side.

When shearing, squeezed ends are acceptable.

Blooms shall be delivered with the production length 2,0 to 6,0m. The utmost deviations from the length should be ±100mm. Actual length shall be agreed in the specification.

4.8 Hot-rolled square bars 0,3149-3,9370 inches (8-100mm) in square side

Square bar sides and utmost deviations from them shall conform to the requirements specified in Table 13.

Table 13. Sides of Hot-Rolled Square Bars and Utmost Deviations from them

Square Side		Utmost Deviations from the Square Side, mm	
inches	mm	lot 1	lot 2
0,3149	8	+0,3/–0,5	—
0,3937	10		
0,4724	12		
0,5511	14		
0,6299	16		
0,7086	18		
0,8661	22	+0,4/–0,5	+0,8/–0,0
0,9842	25		
1,1023	28	+0,3/–0,7	+0,9/–0,0
1,1811	30		
1,2598	32	+0,4/–0,7	+1,1/–0,0
1,3779	35		
1,7716	45	+0,4/–1,0	+1,4/–0,0
1,9685	50		
2,3622	60	+0,5/–1,1	+1,6/–0,0
2,4803	63		
2,5590	65		
2,7559	70		
2,9527	75		
3,1496	80	+0,5/–1,3	+1,8/–0,0
3,5433	90	+0,5/-1,3	+1,8/-0,0
3,9370	100	+0,6/–1,7	+2,3/–0,0

Note: lot number is stated in the specification.

The difference between the diagonals measured at the same cross section shall not exceed the double sum of utmost deviations from the square side for bars up to 20mm inclusive, and for bars over 20mm it shall not exceed the sum of utmost deviations from the square side.

Corner blunting shall not exceed 0,15 of square side.

For bars up to 25mm in square side (inclusive) straightness deviations shall not exceed 0,5% of length, for bars over 25mm in square side it shall be 0,4% of length.

Twisting shall not exceed the following values:

- 4 degrees per meter multiplied by the length value in meters, but not more than 24 degrees when square side is up to 14mm;
- 3 degrees per meter multiplied by the length value in meters, but not more than 18 degrees when square side is over 14mm up to 50mm inclusive;

- 3 degrees per meter multiplied by the length value in meters, but not more than 15 degrees when the square side is over 50mm.

Bar ends shall be straight cut. Inclination from the cut shall not exceed 2mm for bars 8-18mm in square side and 0,1 of square side for bars 22-100mm in square side.

Squeezed ends and burrs not exceeding the utmost plus deviations from the square side are permitted.

Bars shall be produced 3,0 to 6,0m in length with utmost deviations from the length ±100mm. Actual bar length can be agreed in the specification.

4.9 Forged square bars 3,1496-17,7165 inches (80-450mm) in square side

Square side sizes and utmost deviations from them shall meet the requirements of Table 14.

Table 14. Square Sides of Forged Square Bars and Utmost Deviations from them

Square Side		Utmost Deviations, mm
inches	mm	
3,1496-3,3464	80-85	+3,0/–0,0
3,5433-4,1338	90-105	+3,5/–0,0
4,3307-4,5275	110-115	+4,0/–0,0
4,7244-5,7086	120-145	+4,5/–0,0
5,9055	150	+5,0/–0,0
6,1023-6,4960	155-165	+6,0/–0,0
6,6929-7,0866	170-180	+7,0/–0,0
7,2834-7,8740	185-200	+8,0/–0,0 (+5,0/–0,0)
8,0708-17,7165	205-450	+10,0/–0,0 (+5,0/–0,0)

Note: for planed or milled bars utmost deviations are indicated in brackets, for bars with total surface grinding or spot surface grinding utmost deviations are indicated without brackets.

The difference between the diagonals at the same cross section shall not exceed the total utmost deviations from the width for bars up to 200mm in square side and 5% of the square side for bars over 200mm in square side.

Forged bars are produced with sharp edges. Permissible edge blunting is to be 3% maximum of the square side.

For bars with total surface grinding or with spot surface grinding straightness deviations shall not exceed 5mm per 1m of the length and for bars with planed or milled surface straightness deviations shall not exceed 2mm per 1m of length.

When agreed upon by the parties and stated in the specification for bars up to 200mm (inclusive) in square side longitudinal edges may be chamfered up to 8-15mm in width, for bars over 200mm in square side the chamfer may be 10-20mm in width.

Bar ends shall be straight cut. Inclination from the cut shall not exceed 0,1 of the square side.

Bars shall be produced 2,0 to 4,0m in length with utmost deviations from the length ±100mm. Actual bar length can be agreed in the specification.

4.10 Rectangular forgings (forged flats) 1,1811-11,8110 x 3,1496-31,4960 inches (30-300 x 80-800 мм) in cross section

Forging sizes and utmost deviations from them shall conform to the requirements specified in Table 15.

Table 15. Forged Flat Sizes and Utmost Deviations from them

Thickness, mm		Width, mm		Utmost (plus) Deviations, mm		
inches	mm	inches	mm	from thickness	from width	
a) for forgings delivered with spot grinding of surface defects						
1,1811-1,9685	30-50	3,1496-7,8740	80-200	+3,0/–0,0	width, mm	utmost deviations, mm
2,0078-2,3622	51-60	3,1496-7,8740	80-200	+3,5/–0,0	80-119	+4,0/–0,0
2,4015-2,5196	61-64	3,1496-7,8740	80-200	+4,0/–0,0	120-179	+5,0/–0,0
2,5590-3,1496	65-80	3,1496-11,8110	80-300	+4,0/–0,0	180-214	+7,0/–0,0
3,1889-3,5433	81-90	3,1496-11,8110	80-300	+4,5/–0,0	215-249	+8,0/–0,0
3,5826-4,7244	91-120	3,5433-13,7795	90-350	+5,0/–0,0	250-284	+9,0/–0,0
4,7637-5,9055	121-150	3,5433-13,7795	90-350	+6,0/–0,0	285-344	+10,0/–0,0
					345-350	+12,0/–0,0

b) for forgings delivered with total surface grinding, planed or milled					
3,9370	100	11,8110	300	+5,0/–0,0 (+5,0/–0,0)	+10,0/–0,0 (+5,0/–0,0)
3,9763-9,8425	101-250	11,8503-19,6850	301-500	+7,0/–0,0 (+5,0/–0,0)	+15,0/–0,0 (+10,0/–0,0)
9,8818-11,8110	251-300	19,7244-23,6220 23,6614-31,4960	501-600 601-800	+10,0/–0,0 (+5,0/–0,0)	+15,0/–0,0 (+10,0/–0,0) +20,0/–0,0 (+15,0/–0,0)

Note: for planed or milled forgings utmost deviations are indicated in brackets, for forgings with total surface grinding utmost deviations are indicated without brackets.

The difference between the diagonals at the same cross section shall not exceed the total utmost deviations from the width.

Convexity (barrel shape) or concavity of narrow bar sides is allowed. Convexity shall not exceed the width limits. Concavity shall not reduce the bar under the nominal size.

Forgings are delivered with sharp edges. Permissible edge blunting is to be 3% max of thickness.

When agreed upon by the parties and stated in the specification for forgings up to 200mm in thickness longitudinal edge chamfering is to be 8-15mm in width, for forgings over 200mm in thickness it shall be 10-20mm in width.

Non-flatness and camber for forgings with spot surface grinding or with total surface grinding shall not exceed 0,4% of length, and for forgings with planed or milled surface it shall not exceed 0,2% of length.

Forging ends shall be straight cut and deburred. Inclination from the cut shall be 0,1 maximum of thickness.

Forgings shall be produced 2,0 to 4,0m in length. The utmost deviations from length shall be ±100mm. It is permitted to agree other forging length in the specification.

4.11 Round bars 0,750 inches (19,050mm) to 21,500 inches (546,100mm) in diameter delivered with machining allowance at site

When agreed upon by the parties and stated in the specification hot-rolled and forged turned bars 0,750 inches (19,050mm) to 21,500 inches (546,100mm) in diameter shall be delivered with machining allowance at site and utmost plus deviations from diameter at the manufacturer's plant according to the requirements specified in Table 16.

Out-of-round, straightness deviations, end finish, inclination from the cut, bar length shall meet the requirements stated in sections 4.1, 4.3 for hot-rolled and forged bars correspondingly.

Table 16. Nominal Diameter and Utmost Plus Deviations from the Diameter at the Manufacturer's Plant for Hot-Rolled and Forged Bars Delivered with Machining Allowance at Site

Nominal Diameter		Machining Allowance at Site, mm	Actual Bar Diameter, mm		Utmost Plus Deviations from the Diameter at the Manufacturer's Plant, mm
inches	mm		min	max	
0,750	19,050	0,254	19,3	19,9	0,6
0,875	22,225	0,254	22,5	23,1	0,6
1,000	25,400	0,254	25,7	26,3	0,6
1,125	28,575	0,254	28,8	29,4	0,6
1,250	31,750	0,254	32,0	32,6	0,6
1,375	34,925	0,254	35,2	35,8	0,6
1,500	38,100	0,508	38,6	39,2	0,6
1,625	41,275	0,508	41,8	42,4	0,6

1,750	44,450	0,508	45,0	45,6	0,6
1,875	47,625	0,508	48,1	48,7	0,6
2,000	50,800	0,508	51,3	52,1	0,8
2,125	53,975	0,508	54,5	55,3	0,8
2,250	57,150	0,508	57,7	58,5	0,8
2,375	60,325	0,508	60,8	61,8	1,0
2,500	63,500	0,508	64,0	65,0	1,0
2,625	66,675	0,508	67,2	68,2	1,0
2,750	69,850	0,508	70,4	71,4	1,0
2,875	73,025	0,508	73,5	74,5	1,0
3,000	76,200	0,508	76,7	77,7	1,0
3,125	79,375	1,016	80,4	81,6	1,2
3,250	82,550	1,016	83,6	84,8	1,2
3,375	85,725	1,016	86,7	87,9	1,2
3,500	88,900	1,016	89,9	91,1	1,2
3,625	92,075	1,016	93,1	94,3	1,2
3,750	95,250	1,016	96,3	97,5	1,2
3,875	98,425	1,016	99,4	100,8	1,4
4,000	101,600	1,016	102,6	104,0	1,4
4,250	107,950	1,651	109,6	111,0	1,4
4,500	114,300	1,651	116,0	117,4	1,4
4,750	120,650	1,651	122,3	124,1	1,8
5,000	127,000	1,651	128,7	130,5	1,8
5,250	133,350	1,651	135,0	136,8	1,8
5,500	139,700	1,651	141,4	143,2	1,8
5,750	146,0,50	1,651	147,7	149,5	1,8
6,000	152,400	1,651	154,1	155,9	1,8
6,250	158,750	2,413	161,2	163,2	2,0
6,500	165,100	2,413	167,5	169,5	2,0
7,000	177,800	2,413	180,2	182,2	2,0
7,500	190,500	2,413	192,9	194,9	2,0
8,000	203,200	2,413	205,6	208,6	3,0
8,500	215,900	2,413	218,3	221,3	3,0
9,000	228,600	2,413	231,0	234,0	3,0
9,500	241,300	2,413	243,7	246,7	3,0
10,000	254,000	2,413	256,4	259,4	3,0
10,500	266,700	3,175	269,9	272,9	3,0
11,000	279,400	3,175	282,6	285,6	3,0
11,500	292,100	3,175	295,3	298,3	3,0
12,000	304,800	3,175	308,0	311,0	3,0
12,500	317,500	3,175	320,7	323,7	3,0
13,000	330,200	3,175	333,4	336,4	3,0
13,500	342,900	3,175	346,1	349,1	3,0

Table 16 continued

Nominal Diameter		Machining Allowance at Site, mm	Actual Bar Diameter, mm		Utmost Plus Deviations from the Diameter at Manufacturer's Plant, mm
inches	mm		min	max	
14,000	355,600	3,175	358,8	361,8	3,0
14,500	368,300	3,175	371,5	374,5	3,0
15,000	381,000	3,175	384,2	387,2	3,0
15,500	397,700	3,175	396,9	399,9	3,0
16,000	406,400	3,175	409,6	412,6	3,0
16,500	419,100	3,175	422,3	425,3	3,0
17,000	431,800	3,175	435,0	439,0	3,0
17,500	444,500	3,175	447,7	450,7	3,0
18,000	457,200	3,175	460,4	463,4	3,0
20,000	508,000	3,175	511,2	515,2	4,0
21,000	533,400	3,175	536,6	541,6	5,0
21,500	546,100	3,175	549,3	554,3	5,0

Note: when agreed upon by the parties and stated in the specification bars shall be produced with intermediate diameters with the utmost deviations form the nearest smallest diameter.

5. TECHNICAL REQUIREMENTS

5.1. Steel products shall be delivered in annealed or normalized condition and without heat treatment that shall be stated in the specification.

All annealed or normalized steel products shall have hardness conforming to the values specified in Table 17.

Table 17. Hardness of Steel Products of Carbon Structural and Alloy Structural Steel in Annealed and Normalized Condition

Steel Grade		Hardness, HB	
ASTM	GOST	as annealed	as normalized
1018, 1018-MOD, ESMS-1018	17, 17-У1, 17-У2, 17А, 18, 18-У1, 18-У2, 18А	≤149	115-182
1020, 1022	20, 20-У1, 20-У2, 20А 22, 22-У1, 22-У2, 22А	≤156	120-190
1030, 1030-MOD	30, 30-У1, 30-У2, 30А, 31, 31-У1, 31-У2, 31А	≤175	157-207
1035	35, 35-У1, 35-У2, 35А	≤183	157-207
1040	40, 40-У1, 40-У2, 40А	≤197	157-207
1040/1042, 1042	41, 41-У1, 41-У2, 41А 42, 42-У1, 42-У2, 42А	≤207	157-207
1045, ESMS-1045	45, 45-У1, 45-У2, 45А	≤207	157-207
1050	50, 50-У1, 50-У2, 50А	≤217	≤250
1055	55, 55-У1, 55-У2, 55А	≤229	≤250
1060	60, 60-У1, 60-У2, 60А	≤241	≤255
4130, 4130H	30ХМ, 30ХМ-У, 30ХМ-У1, 30ХМ-У2, 30ХМА	≤209	-
4140, 4140-MOD, 4140H, ESMS-4140, 4140CaLPA	40ХГМ, 40ХГМ-У, 40ХГМ-У1, 40ХГМ –У2, 40ХГМА, 41ХГМ, 41ХГМ-У1, 41ХГМ-У2, 41ХГМА	≤229	-
4142, 4142H	42ХГМ, 42ХГМ-У, 42ХГМ-У1, 42ХГМ-У2, 42ХГМА	≤229	-
4145, 4145H	45ХГМ, 45ХГМ-У, 45ХГМ-У1, 45ХГМ-У2, 45ХГМА	≤235	-
4150, 4150H	50ХГМ, 50ХГМ-У, 50ХГМ-У1, 50ХГМ-У2, 50ХГМА	≤229	-

Table 17 continued

Steel Grade		Hardness, HB	
ASTM	GOST	as annealed	as normalized
4340, 4340H	40ХГН2М, 40ХГН2М-У, 40ХГН2М-У1, 40ХГН2М-У2, 40ХГН2МА	≤235	-
6150, 6150H	50ХГФ, 50ХГФ-У, 50ХГФ-У1, 50ХГФ-У2, 50ХГФА	≤248	-
8620, 8620H, ESMS-8620	20ХГНМ, 20ХГНМ-У, 20ХГНМ-У1, 20ХГНМ-У2, 20ХГНМА	≤210	≤229

When agreed upon by the parties and stated in the specification metal products of 4140, 4140H, ESMS-4140, 4140CaLPA steel grades shall be delivered after LP (lamellar pearlite) annealing. Lamellar pearlite microstructure in these steel products is evaluated in accordance with manufacturer's practice, the evaluation results shall be indicated in the certificates as follows: "LP ANNEALED".

5.2. Surface quality requirements

5.2.1. Round bars 20-40mm in diameter shall be delivered in peeled or ground condition and bars over 40 to 550mm in diameter shall be delivered in peeled/turned condition with surface roughness Rz 80mkm maximum. When agreed upon by the parties and stated in the specification hot-rolled round bars 8-130mm in diameter can be delivered without machining with spot surface grinding.

Cracks, laps (forging folds), scabs, rolled (forged) impurities, hairlines, rolled (forged) crusts, rolled (forged) blisters are not allowed on the surface of round bars with machined surface or without surface machining.

Local surface imperfections of bars with and without machining 129mm and over in diameter shall be removed by flat grinding. The width of grind-outs shall not exceed 5 times the depth.

For peeled/ turned bars up to 129mm in diameter spot grinding is not allowed.

It is permitted to remove single surface imperfections on peeled/ turned bars 129mm and over in diameter by flat grinding. The depth of grinding for bars up to 180mm in diameter shall not exceed 1,0% of nominal diameter and for bars over 180mm in diameter it shall not exceed 2,0mm measuring on actual size. At that 3 grind-outs maximum are permitted on the surface of a bar, 2 grind-outs at the same cross section are not allowed.

The depth of grind-outs of round bars without machining up to 80mm in diameter shall not exceed ½ of the total utmost deviations from diameter and for bars 80-130mm in diameter it shall not exceed the total utmost deviations from diameter measuring on actual size. At the same cross section 2 grind-outs maximum are allowed.

On the surface of turned round bars and bars without turning single scratches, marks, indentations and other surface defects of mechanical origin are allowed without flat grinding, if their depth does not exceed ½ of the total utmost deviations from diameter counting from the actual size.

Welding or weld repair of surface defects is not permitted.

5.2.2. Flat and square bars and billets up to 100mm (inclusive) in thickness or square side are delivered with spot grinding of surface defects.

Flat and square bars and billets over 100mm in thickness or square side are delivered with total surface conditioning or with planed (milled) surface with roughness Rz 100μm maximum.

When agreed upon by the parties and stated in the specification flats, square bars and billets over 100mm in thickness or square side are delivered with spot grinding of surface defects.

Blooms shall be delivered with total surface conditioning. Surface roughness Rz shall be 100μm maximum.

The type of surface finishing shall be stated in the specification.

Surface of flats, blooms, square bars and billets shall be free of cracks, laps (forging folds), scabs, rolled (forged) impurities, hairlines, rolled (forged) crusts, rolled (forged) blisters.

Local defects shall be removed by flat grinding. The width of flat grinding shall be 5 times min the depth.

For flats, square bars and billets up to 80mm in thickness or square side the depth of grinding shall not exceed ½ of the total utmost deviations from the thickness or square side. For flats, square bars and billets 80-100mm in thickness or square side this depth shall not exceed the total utmost deviations from the thickness or square side. For flats, blooms, square bars and billets over 100mm in thickness or square side (bloom side) with ground surface the depth of grinding shall not exceed 5% of thickness or square side (bloom side) counting from actual size. For planed or milled bars and flats the depth of grinding shall not reduce the size under minimal permissible one.

Scratches, marks and other defects of mechanical origin are permitted without flat grinding if their depth is:

- 1,0mm max for flats, square bars and billets up to 100mm in thickness or square side;
- 2,0mm max for flats, square bars and billets 100-180mm in thickness or square side;
- 2,5mm max for flats, blooms, square bars and billets over 180mm in thickness or square side (bloom side).

Welding or weld repair of surface defects is not permitted.

5.2.3. Surface defects of mechanical origin not exceeding ½ of utmost deviation from diameter in depth are permitted on the surface of ground and polished bars.

Surface roughness Ra shall not exceed 2,5μm.

5.2.4. Surface defects of mechanical origin are permitted on the surface of hot-rolled or forged ground and polished bars 12-200mm in diameter produced on the *Landgraf* automatic line if their depth does not exceed the following values:

- 0,040mm for bars 12,00-80,00mm in diameter with size tolerance h9 (k9) and for bars 12,00-18,00mm in diameter with size tolerance h10 (k10);
- ½ of utmost deviation from diameter for bars over 18,00 to 80,00mm in diameter with size tolerance h10 (k10), for bars 12,00-80,00mm in diameter with size tolerance h11 (k11) and for bars over 80 to 200mm in diameter with size tolerance h9-h11 (k9-k11).

Surface roughness Ra shall not exceed 1,4μm for bars up to 130mm in diameter and 4,0μm for bars 130mm and over in diameter.

5.3. Steel macrostructure determined on etched specimens (templates) shall be free of pipe cavity, porosity, blisters, cracks, slag inclusions and flakes and shall conform to photographs S-1, S-2, R-1, R -2, C-1, C-2 , ASTM E 381.

5.4. Austenitic grain size shall be 5-8 or 2 numbers finer in accordance with ASTM E112.

5.5. Steel is delivered after non-metallic inclusion test performed in accordance with ASTM E45 (Method A).

Results of non-metallic inclusions evaluation shall conform to the requirements stated in Table 18.

Table 18. Average Rating of Non-Metallic Inclusion Content

Melting Process	Average Rating of Non-Metallic Inclusion Content, max				
	Inclusion Series	Inclusion Type			
		A	B	C	D
In electric arc furnaces with vacuum degassing	thin thick	2,5 2,0	2,5 2,0	2,5 2,0	2,5 2,0
In electric arc furnaces without vacuum degassing	thin thick	3,0 2,0	3,0 2,0	3,0 2,0	3,0 2,0
ESR	thin thick	2,5 1,5	2,0 0,5	0,5 0,5	1,0 0,5

Note: for steel grades with specified inferior sulfur limit, non-metallic inclusions of A-type are not subject to rejection.

5.6. Metal products of 4130H, 4140H, 4142H, 4145H, 4150H, 4340H, 6150H, 8620H steel grades shall be delivered after end-quench hardenability test in accordance with ASTM A 255.

Rockwell hardness limits at end-quench hardenability testing shall conform to the requirements specified in Table 19.

Prior to specimen preparing for end-quench hardenability test specimen blank shall be normalized.

Normalization and quenching temperature for specimens shall conform to the requirements specified in Table 20.

Table 20. Normalization and Quenching Temperature

Steel Grade		Normalization Temperature		Quenching Temperature	
ASTM	GOST	ºF	ºC	ºF	ºC
4130H	30ХМ-У	1650	899	1600	871
4140H	40ХГМ-У	1600	871	1550	843
4142H	42ХГМ-У	1600	871	1550	843
4145H	45ХГМ-У	1600	871	1550	843
4150H	50ХГМ-У	1600	871	1550	843
4340H	40ХГН2М-У	1600	871	1550	843
6150H	50ХГФ-У	1650	899	1600	871
8620H	20ХГНМ-У	1700	927	1700	927

Utmost variations in normalization temperature are ±15ºC, in quenching temperature are ±5ºC.

Ideal diameter value (Di) is estimated according to actual chemical composition values of each heat in accordance with ASTM A 255.

5.7. Metal products 20mm and over in diameter or in thickness shall be US-tested in accordance with EN 10308 (for rolled steel) and in accordance with EN 10228-3 (for forged steel) with testing scheme for 1a-type (round steel products) and for 1b-type (square and rectangular steel products).

Testing results shall conform to the requirements specified in Table 21.

Table 21. US-Test Requirements

Diameter or Thickness, mm	Steel Products			
	rolled		forged	
	Quality Class acc. to EN 10308		Quality Class acc. to EN 10228	
	Testing Scheme			
	1a-type (for round steel products)	1b-type (for square and rectangular steel products)	1a-type (for round steel products)	1b-type (for square and rectangular steel products)
20-80	4		3	
over 80 to 180	3		3	
over 180	2		3	

Note: it is permitted to agree the other US-test requirements upon in the specification.

Table 19. Rockwell Hardness Limits

Distance from the End		Hardness, HRC															
inches x1/16	mm	Steel Grade															
		4130H/30ХМ-У		4140H/40ХГМ-У		4142H/42ХГМ-У		4145H/45ХГМ-У		4150H/50ХГМ-У		4340H/40ХГН2М-У		6150H/50ХГФ-У		8620H/ 20ХГНМ-У	
		max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
1	1,6	56	49	60	53	62	55	63	56	65	59	60	53	65	59	48	41
2	3,2	55	46	60	53	62	55	63	55	65	59	60	53	65	58	47	37
3	4,8	53	42	60	52	62	54	62	55	65	59	60	53	64	57	44	32
4	6,4	51	38	59	51	61	53	62	54	65	58	60	53	64	56	41	27
5	7,9	49	34	59	51	61	53	62	53	65	58	60	53	63	55	37	23
6	9,5	47	31	58	50	61	52	61	53	65	57	60	53	63	53	34	21
7	11,1	44	29	58	48	60	51	61	52	65	57	60	53	62	50	32	-
8	12,7	42	27	57	47	60	50	61	52	64	56	60	52	61	47	30	-
9	14,3	40	26	57	44	60	49	60	51	64	56	60	52	61	43	29	-
10	15,9	38	26	56	42	59	47	60	50	64	55	60	52	60	41	28	-
11	17,5	36	25	56	40	59	46	60	49	64	54	59	51	59	39	27	-
12	19,1	35	25	55	39	58	44	59	48	63	53	59	51	58	38	26	-
13	20,6	34	24	55	38	58	42	59	46	63	51	59	50	57	37	25	-
14	22,2	34	24	54	37	57	41	59	45	62	50	58	49	55	36	25	-
15	23,8	33	23	54	36	57	40	58	43	62	48	58	49	54	35	24	-
16	25,4	33	23	53	35	56	39	58	42	62	47	58	48	52	35	24	-
18	28,6	32	22	52	34	55	37	57	40	61	45	58	47	50	34	23	-
20	31,8	32	21	51	33	54	36	57	38	60	43	57	46	48	32	23	-
22	34,9	32	20	49	33	53	35	56	37	59	41	57	45	47	31	23	-
24	38,1	31	-	48	32	53	34	55	36	59	40	57	44	46	30	23	-
26	41,3	31	-	47	32	52	34	55	35	58	39	57	43	45	29	23	-
28	44,5	30	-	46	31	51	34	55	35	58	38	56	42	44	27	22	-
30	47,6	30	-	45	31	51	33	55	34	58	38	56	41	43	26	22	-
32	50,8	29	-	44	30	50	33	54	34	58	38	56	40	42	25	22	-

5.8. Reduction ratio shall be 4,0 min for all types of products that is provided by manufacturer's technology.

Reduction ratio for round and square steel products over 180mm in diameter or thickness and for flats over 180mm in equivalent diameter shall be stated on the inspection certificate.

5.9. Steel products shall be tested for mixing by spark method or by steeloscope, or other non-destructive methods.

5.10. Steel products shall be radiation and mercury free, which is provided by the manufacturer's technology.

5.11. Steel products with turned, planed or milled surface and with ground and polished surface shall be decarburization free which is provided by the manufacturer's technology.

Decarburization depth of square bars, flats and billets up to 150mm in square side or thickness with spot surface grinding, of round bars without turning of all steel grades with carbon content over 0,30% (by inferior limit) shall not exceed 1,5%.

Decarburization depth of square bars and flats over 150mm in square side or thickness with spot surface grinding is not tested.

6. ACCEPTANCE RULES AND TESTING METHODS

Acceptance rules and testing methods shall be in accordance with GOST 4543 with the following details:

- austenitic grain size is evaluated in accordance with ASTM E 112;
- non-metallic inclusions are evaluated according to ASTM E45, Method A;
- US-testing shall be performed in accordance with EN 10308 (for rolled steel products) and in accordance with EN 10228-3 (for forged steel products); for bars, billets, flats up to 100mm (inclusive) in diameter or thickness 10% of shipping lot is US-tested; for bars, blooms, billets and flats over 100mm in diameter or thickness 100% of shipping lot is US-tested;
- macrostructure is determined in accordance with ASTM E381;
- hardenability is tested in accordance with ASTM A 255;
- for steel products over 140mm in diameter or thickness it is permitted to check macrostructure, non-metallic inclusions and austenitic grain size on samples reforged into round or square 90-100mm in cross section;
- for bars with ground and polished surface produced on the *Landgraf* automatic line diameter, out-of-round and surface roughness are checked at a distance of 25mm min and 50mm min from the bar end for bars up to 50,00mm and over 50,00mm in diameter correspondingly.

7. MARKING AND PACKING

7.1. Hot-rolled and forged bars, billets, blooms, hot-rolled and forged flats shall be tightly packed in bundles. Each bundle shall be banded 3-4 times in 2-3 places with wire 5-7mm in diameter or with steel strip 0,8-1,5mm in thickness and 30-35mm in width.

One end of each steel bar over 42mm in diameter or thickness shall be stamped with indication of heat number, steel grade designation according to ASTM, manufacturer's logo, and the sign (digital code) of a quality control inspector. Bars, billets, blooms, flats ends opposite to the stamped ones shall be painted in accordance with the specification.

Forgings (forged bars) over 180mm in diameter or thickness shall be additionally stamped with indication of bar size, weight, piece number .

For bars and flats up to 42mm (inclusive) in diameter or thickness 5-7 pieces of the bundle shall be stamped with indication of heat number, steel grade designation according to ASTM, manufacturer's logo, sign (digital code) of a quality control inspector. Stamped bar ends shall be coloured.

When agreed upon by the parties and stated in the specification metal products with turned, planed (milled) surface or with total surface conditioning shall be covered with mineral oil or lubricant preserving from corrosion.

Bundle weight shall not exceed 5,0 tons. When agreed upon by the parties and stated in the specification it is permitted to deliver bundles under 5,0 tons in weight.

7.2. Ground and polished bars up to 10,0mm in diameter shall be rigidly tied at 3 places and wrapped in waterproof paper and after that in polyethylene or PVC film. Bundle of bars up to 10,0mm in diameter shall be 80kg max in weight.

Each bundle shall have 2 tags. Bundles of bars up to 10,0mm in diameter should be placed in wooden boxes. Box gross weight shall be 2000kg max. Marking tags shall be attached to faces of each box.

Ground and polished bars over 10,0mm in diameter shall be wrapped in waterproof paper and after that in polyethylene or PVC film.

When agreed upon by the parties and stated in the specification other types of packing materials can be used.

Each bundle of bars over 10,0mm in diameter shall contain 5 bars min stamped with indication of heat number and steel grade designation according to ASTM. For bars produced on the *Landgraf* automatic line it is permitted to identify bars with heat number and steel grade designation according to ASTM using indelible ink instead of stamp marking. Stamped (marked) bar ends shall be coloured in accordance with the requirements stated in the specification.

Each bundle shall be banded 2-3 times in 2-3 places with wire 5-7mm in diameter or with steel strip 0,8-1,5mm in thickness and 30-35mm in width. Bundles shall be tightly packed and rigidly tied. Wooden lagging under strapping up to the manufacturer's design should be used.

Bundle weight shall not exceed 2,5 tons.

Ground and polished bars shall be coated with corrosion preventing lubricant prior to packing.

7.3. Each bundle shall have two tags (one on each side) with the following information in English:

- contract number;
- specification number;
- manufacturer;
- buyer;
- steel grade according to ASTM;
- section size, inches and mm;
- lot number for hot-rolled bars and size tolerance for ground and polished bars;
- length, mm;
- net/gross weight, pounds and kg;
- heat number;
- lot number (for ground and polished bars);
- package number and number of packages.

8. SUPPLEMENTARY AND SPECIAL REQUIREMENTS

Customer's supplementary and special requirements (to individual specifications as well) including diversificaion of product range, changes in technical requirements are to be stated separately in a Technical Protocol. The Technical Protocol is an integral part of the contract.

9. INSPECTION CERTIFICATE

Products shall be accompanied with the Inspection Certificate conforming to EN 10204, form 3.1. B in English including the following:

- chemical composition and melting process;
- steel grade according to ASTM;
- heat number;
- lot number (for ground and polished bars);
- section size, inches and mm;
- lot number for hot-rolled bars and size tolerance for ground and polished bars;
- length, mm;
- net weight, pounds and kg;
- specification number and contract number;
- test results: macro- and microstructure, grain size, non-metallic inclusions, hardenability, ideal diameter size (Di), US-testing, as delivered hardness, decarburization depth, mixing, and reduction ratio for round and square metal products over 180mm in diameter or thickness and for flats over 180mm in equivalent diameter.

The following also should be stated in the certificate:

- “Made in Ukraine";
- “Radiation Free”;
- “Mercury Free”;
- “No Weld or Weld Repair”;
- in the section “macrostructure” “ASTM E 381”;
- in the line “steel grade” “ASTM A29/A29M, ASTM A 576” – for steel grades with chemical composition according to Table 1; “ASTM A29/A29M, ASTM A 322” – for steel grades with chemical composition according to Table 2 and “ASTM A 304" – for steel grades with chemical composition according to Table 3;
- in the section “non-metallic inclusions” “ASTM E 45, method A”;
- in the section “austenitic grain size” “ASTM E 112”;
- in the section “US-test” “EN 10308” – for rolled steel products; “EN 10228-3” – for forged steel products.

Note: the certificate shall contain the following statement “after dimension/surface defect test”.

REFERENCE STANDARDS

ASTM A29/A29M	Standard Specification for Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-Finished, General Requirements for
ASTM A 255	Standard Test Method for Determining the Hardenability of Steel
ASTM A 304	Standard Specification for Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements
ASTM A 322	Standard Specification for Steel Bars, Alloy, Standard Grades
ASTM A 576	Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM E45	Standard Test Methods for Determining the Inclusion Content of Steel
ASTM E112	Standard Test Methods for Determining Average Grain Size
ASTM E 381	Standard Method of Macroetch Testing, Inspection, and Rating Steel Products, Comprising Bars, Billets, Blooms, and Forgings
EN 10204	Metallische Erzeugnisse – Arten von Prüfbescheinigungen
EN 10308	Ultraschallprüfung von Stäben aus Stahl
EN 10228-3	Non-Destructive Testing of Steel Forgings – Part 3: Ultrasonic Testing of Ferritic or Martensitic Steel Forgings
ГОСТ 4543	Прокат из легированной конструкционной стали.