



LARGE DIAMETER PIPES

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TMK AT A GLANCE

TMK is an industrial engineering company and leading supplier of tubular solutions, structural materials, and related services. The company manufactures steel pipes, pipeline systems, and other products for the oil and gas, energy, chemical, mechanical engineering and construction industries. Its product portfolio includes pipes made of carbon, alloy and special steel.

The company comprises modern industrial complexes, including eco-efficient electric steelmaking shops, a wide range of rolling mills, and finishing capacities located across several Russian regions, along with trade offices domestically and internationally.

TMK also operates facilities for the development and production of pipeline components and equipment for the energy sector, pre-assembled units, heavy machinery products, and other complex items. With its own engineering center and steel structure manufacturing capabilities, the company delivers comprehensive turnkey infrastructure projects for its customers.

TMK includes oilfield service enterprises under the TMK NGS brand, offering pipe repair, thread cutting, inventory management, coating application, and the production of downhole equipment.

TMK is enhancing its scientific and technical expertise and developing advanced solutions with the support of its R&D centers in Moscow and Chelyabinsk. TMK's facilities support the full cycle of creating advanced pipe solutions—from concept development to testing and production launch.



PRODUCTION OF LONGITUDINAL WELDED LDP

Electric-welded large diameter pipes (LDP) are designed for construction of line pipelines in any climatic zones, including the Far North and sea areas. TMK produces pipes with advanced performance characteristics for main gas, oil and oil product pipelines, underwater pipelines, pipelines of high corrosion resistance, for building structures, as well as for the construction of pipelines for various purposes, including water pipelines, heat network pipelines, low-pressure gas pipelines, urban and settlement gas supply systems with high-pressure natural and liquefied gas, complying with Russian and world standards GOST, TU, ISO, EN, API and other.

Large diameter pipes are produced by TMK PS in Chelyabinsk, Volzhsky, and in Seversky Pipe Plant.

TMK PS is a successor of CHTPZ and VTZ in large diameter pipe manufacturing, including application of various types of coatings.

TMK PS's electric welding pipe shops Vysota 239 and No. 6 in Chelyabinsk use submerged arc longitudinal welding to produce single and double-seam pipes with diameters from 508 mm to 1,422 mm and wall thicknesses up to 48 mm.

On the basis of electric welding pipe shop Vysota 239, the innovative industrial production of LDP with a longitudinal weld made with the use of laser-hybrid welding (LHW) was implemented for the first time in the global practice of LDP manufacturing.

Electric-Weld Pipe Shop No. 6 comprises a section producing double-seam longitudinal welded pipes with diameters from 1,520 mm to 2,520 mm and a wall thickness from 15 mm to 34 mm.

STZ operates a mill to manufacture electric-welded pipes using the high-frequency welding technology, which

allows it to produce pipes with diameters from 219 mm to 530 mm.

Most pipelines in Russia are built with pipes manufactured by TMK plants. Combining ease of supply to Central Russia, Siberia, the Far East, Kazakhstan, and China with proximity to major plate rolling mills, CHTPZ is optimally positioned to derive multiple synergies.

Volzhsky Pipe Plant's advantageous geography, access to rail and motor transport, and proximity of sea and river routes enable on-time product delivery to its customers.

Seversky Pipe Plant benefits from proximity to the oil and gas provinces of the Khanty-Mansi Autonomous Area, Yamalo-Nenets Autonomous Area and Siberia.



STANDARDS FOR SAWL

TMK PS produces both single-seam longitudinal welded pipes at the Vysota 239 electric-weld pipe shop (Chelyabinsk), Electric-Weld Pipe Shop No. 6 (Chelyabinsk), and Electric-Weld Pipe Shop No. 1 (Volzhsky) and 1,020–1,220 mm double-seam longitudinal welded pipes made from two half-cylinders at Electric-Weld Pipe Shop No. 6 (Chelyabinsk). Electric-Weld Pipe Shop No. 6 has a section producing double-seam pipes ranging from 1,520 mm to 2,520 mm in diameter for general purposes, construction, etc. In its production, TMK PS uses all three pipe forming processes used globally to manufacture large-diameter longitudinal welded pipes: three-roll bending

(TRB), press forming (UO), and step-by-step forming (JCO). The plant's production lines can produce pipes with lengths of up to 18 m and in grades up to K80 (Russian classification) and up to X100 (L690) (ISO and API classification). The site uses the most advanced technologies and highly automated processes to produce state-of-the-art pipe. The technology solutions are continuously improved, along with product quality. The hybrid laser-arc welding technology implemented and used at TMK PS to weld longitudinal pipe seams is unique in the industry.

Quality Policy

As high standards for product quality are essential for winning customer loyalty, TMK is committed to following global best practices in all aspects of its operations.

A Quality Management System certified to ISO 9001:2008 is in place at all TMK plants.

The Company takes a responsible approach to environmental protection and social commitments, and is actively engaged in addressing environmental problems in the region.

An Environmental Management System in place at its plants is certified to ISO 14001:2004.

All large diameter pipes are subject to mandatory non-destructive testing, including ultrasonic, X-ray and magnetic particle inspections, as well as mechanical testing, chemical analysis, and hydrostatic testing.

2.1 Standards for SAWL

Standards	Pipes dimensions		Steel and pipes grade
	Outside diameter, mm	Wall thickness, mm	
1	2	3	4
GOST ISO 3183-2015 Steel pipes for pipelines of petroleum and natural gas industries	508–1,422	7.0–48.0	A, B, X42, X46, X52, X56, X60, X65, X70, X80, L245, L290, L320, L360, L390, L415, L450, L485, L555
GOST 10704-91 / GOST 10706-76 Electrically welded steel line-weld tubes	508–1,420 1,520–2,520	7.0–48.0	St2kp (K33), St2ps, St2sp (K34), St3kp (K37), St3ps, St3sp (K38), Low-alloy steels (CE ≤ 0.48), K45
GOST 20295-85 Steel welded pipes for main gas-and-oil pipelines	508–1,420	7.0–48.0	Carbon and low-alloy steels of grades 3Sp (K34), K38, st20 (K42), K48, K50, K52, K54, K55, K56, K60
GOST 31447-2012 Steel welded pipes for trunk gas pipelines, oil pipelines, and oil products pipelines	530–1,420	7.0–48.0	Carbon and low-alloy steels of grades K34, K38, K42, K48, K50, K52, K54, K55, K56, K60
GOST 33228-2015 General purpose steel welded pipes	508–1,420 1,520–2,520	7.0–34.0	KP175–KP460
GOST R 58064-2018 Steel welded pipes for building structures	508–1,420	8.0–48.0	C245–C440
TU 24.20.21-001-57357928-2022 Longitudinal electric-welded steel pipes of grade K60 for gas trunk pipelines with an operating pressure of 11.8 MPa and gathering gas pipelines with an operating pressure of 12.9 MPa	530–1,420	9.9–37.9	K60
TU 24.20.21-006-57357928-2022 Longitudinal electric-welded steel pipes of grade K65 with a diameter of 1,420 mm for gas trunk pipelines with an operating pressure of 11.8 MPa	1,420	23.0 27.7 33.4	K65
TU 24.20.21-012-57357928-2022 Longitudinal electric-welded steel pipes for encasements with diameters from 530 mm to 1,420 mm	530–1,420	15.2–32.0	K34, K38, K42, K48, K50, K52, K54, K55
TU 24.20.21-016-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 508 mm to 1,420 mm for gas trunk pipelines with an operating pressure of up to 9.8 MPa inclusive	508–1,420	7.0–32.0	K52, K54, K55, K56, K60, X56, X60, X65, X70
TU 24.20.21-018-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 530 mm to 1,220 mm for pipelines	530–1,220	7.0–35.0	K50, K52, K54, K55, K56, K60
TU 24.20.21-020-57357928-2022 Improved low-temperature service longitudinal electric-welded steel pipes with diameters from 530 mm to 1,420 mm with enhanced weldability for use in steel structures of buildings	530–1,420	7.0–45.0	K52, K54, K56, K60, X56, X60, X65, X70
TU 24.20.21-027-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 530 mm to 1,420 mm for gas trunk pipelines with an operating pressure of up to 9.8 MPa inclusive, crossing active tectonic fault zones	530–1,420	8.0–40.0	K52, K54, K55, K56, K60, X52, X56, X60, X65, X70
TU 24.20.21-060-57357928-2022 Longitudinal electric-welded steel pipes for hydrogen sulfide service to be used in the construction and repair of pipelines in Central Asia	530–1,220	8.0–30.0	K48, K50, K52, X42, X46, X52
TU 24.20.21-061-57357928-2022 Longitudinal electric-welded steel pipes for gas gathering systems	530	16.0–26.0	K60
TU 24.20.21-067-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 508 mm to 1,422 mm for trunk and gathering pipelines	508–1,422	8.0–38.0	K52, K55, K56, K60, X56, X60, X65, X70
1	2	3	4

Standards	Pipes dimensions		Steel and pipes grade
	Outside diameter, mm	Wall thickness, mm	
1	2	3	4
TU 24.20.21-068-57357928-2022 Longitudinal electric-welded steel pipes for unique building structures	508–1,420	7.0–45.0	S345, S375, S390, S440, K52, K55, K56, K60, X56, X60, X65, X70
TU 24.20.21-074-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 530 mm to 820 mm for trunk and gathering pipelines	530–820	8.0–12.0	K52, K55, K56, K60, X56, X60, X65, X70
TU 24.20.21-076-57357928-2022 Longitudinal electric-welded steel pipes for gathering pipelines with an operating pressure of up to 24.0 MPa inclusive	508	22.2 23.8 24.9	X65, SAWL 450 IFD
TU 1381-079-00186654-2016 Longitudinal electric-welded steel pipes of carbon or low-alloy steel for steam and hot water pipelines	530–1,420	8.0–25.0	St3sp, 20, 09G2S, 17GS, 17G1S, 17G1S-U
TU 24.20.21-1573-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 530 mm to 1,420 mm and wall thicknesses of up to 32 mm for gas, oil, and petroleum product trunk pipelines	530–1,420	8.0–32.0	12G2S, 09G2S, 17GS, 17G1S, 17G1S-U, 13GS, 13GS-U, 08GBYu, 12GSB, 09GSF, 13KhFA, 13G1S-U, 12G2SB, 09GBYu, 09G2FB, 10G2FBYu, 08G1NFB (pipe grades K50, K52, K54, K55, K56, K60)
TU 14-3-1698-2000 Longitudinal electric-welded steel pipes with a diameter of 1,020 mm to 1,220 mm for gas and oil pipelines	1,020, 1,220	10.0–22.0	K52, K55, K56, K60
TU 24.20.21-200-57357928-2022 Normal and low-temperature service longitudinal electric-welded steel pipes with high operational reliability for trunk pipelines	530–1,220	8.0–35.0	K50, K52, K54, K55, K56, K60
TU 24.20.22-201-57357928-2022 Longitudinal electric-welded steel pipes of grade K65 with a diameter of 1,420 mm for gas trunk pipelines with an operating pressure of 11.8 MPa	1,420	23.0, 27.7	K65
TU 24.20.21-202-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 530 mm to 1,420 mm for trunk and gathering pipelines with an operating pressure of up to 10.0 MPa inclusive	530–1,420	8.0–32.0	K52, K54, K55, K56, K60, K65, X56, X60, X65, X70, X80
TU 24.20.21-203-57357928-2022 Longitudinal electric-welded steel pipes for gas trunk pipelines with an operating pressure of up to 9.8 MPa (100 kgf/cm²) inclusive, operated in active tectonic fault zones, in earthquake-prone areas, and in permafrost zones	530–1,420	10.0–32.0	K52, K54, K55, K56, K60, X52, X56, X60, X65, X70
TU 24.20.21-204-57357928-2022 Longitudinal electric-welded steel pipes of grade K60 with diameters from 530 mm to 1,420 mm for gas trunk pipelines with an operating pressure of 11.8 MPa	530–1,420	8.0–38.0	K60
TU 24.20.21-205-57357928-2022 Longitudinal electric-welded steel pipes with outside diameters from 530 mm to 1,220 mm for underwater gas pipelines	530–1,220	8.0–32.0	SMYS 245–485
TU 24.20.21-206-57357928-2022 Highly corrosion-resistant, improved low-temperature service longitudinal electric-welded steel pipes for pipelines	530–1,420	8.0–36.0	20A, 20FA, 09G2S, 17G1S-U, 09GSF, 13KhFA (K48, K50, K52), K54, K55, K56, K60
TU 24.20.21-207-57357928-2022 Longitudinal electric-welded steel pipes for pipelines	530–1,420	8.0–36.0	K42–K60, V1, 2, K34–K60, V3
1	2	3	4

Standards	Pipes dimensions		Steel and pipes grade
	Outside diameter, mm	Wall thickness, mm	
1	2	3	4
TU 24.20.21-208-57357928-2022 Longitudinal electric-welded steel pipes for oil and gas gathering pipelines	530–1,020	8.0–32.0	L360–L485, 09GSF, 05KhGB, 13KhFA
TU 24.20.21-209-57357928-2022 Longitudinal electric-welded steel pipes with outside diameters from 530 mm to 1,420 mm for construction and repair of steam and water pipelines	530–1,420	8.0–25.0	St3sp, 09G2S, 17GS, 17G1S, 17G1SU
TU 24.20.21-210-57357928-2022 Electric-welded steel pipe for encasements	530–1,420	15.2–32.0	K34, K38, K42, K48, K50, K52, K54, K55
TU 24.20.13-213-57357928-2022 Longitudinal electric-welded steel pipes for subsea pipelines	530–820	15.0–27.0	PCT 36W, PCT 40W, PCT 420W X52, X60, X65, K54, K55, K56
TU 14-158-136-2007 Highly corrosion-resistant, improved low-temperature service longitudinal electric-welded pipes of 20 and 20KSKh steel for oil and gas pipelines	530–1,220	7.0–22.0	20, 20KSKh
TU 14-158-153-05 (double-seam modification) Longitudinal electric-welded steel pipes with a diameter of 1,020 mm to 1,220 mm for gas and oil pipelines	1,020, 1,220	10.0–22.0	17G1S-U, 09GSF, 13GS, 13GSU, 13G1SU, 12GSB, 12G2SB, 08G1NFBYu, 10G2FBYu, grades K52–K60
TU 14-3P-1270-2009 Longitudinal electric-welded steel pipes with a diameter of 530 mm, 720 mm, or 820 mm for gas and oil trunk pipelines	530–820	7.0–15.0	17GS, 17G1S, 17G1S-U, 13GS, 13GSU, 13G1SU, 08GBYu, 09GBYu, 12GSB, 12G2SB, 08G1NFBYu, 10G2FBYu, 09GSF, grades K52–K60
TU 24.20.21-164-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 508 mm to 1,422 mm	508–1,422	7.5–48.0	L360–L485, 09GSF, 05KhGB, 13KhFA
TU 24.20.21-021-57357928-2022 Longitudinal electric-welded steel pipes for onshore and offshore gathering pipelines	508, 514, 813, 820	27.0, 30.1, 30.2, 32.2, 38.7, 40.8, 45.8, 46.8	K60, X65, 450 I FD
TU 24.20.21-039-57357928-2022 Longitudinal electric-welded steel pipes for underwater pipelines	508–1,220	8.0–41.0	X60, X65, X70, SAWL 415 IFD, SAWL 450 IFD, SAWL 485 IFD
TU 24.20.21-077-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 508 mm to 1,422 mm for use in a wide temperature range from minus 60 °C to plus 400 °C	508–1,422	8.0–40.0	K50, K52, K54, K55, K56, K60, X56, X60, X65, X70
TU 24.20.21-102-57357928-2022 Highly corrosion-resistant, high-reliability, longitudinal electric-welded steel pipes for pipelines	530–1,420	7.0–40.0	09GSF, 13KhFA
TU 24.20.21-103-57357928-2022 Low-temperature service longitudinal steel pipes for pipelines	530–1,420	7.0–40.0	K48, K50, K52, K54, K55, K56, K60
TU 24.20.21-106-57357928-2022 Longitudinal electric-welded steel pipes for pipelines with an operating pressure of up to 24.0 MPa inclusive	508–812.8	24.9–39.0	K60, X70
TU 24.20.21-108-57357928-2022 Longitudinal welded steel pipes with diameters from 508 mm to 1,422 mm made using laser-hybrid welding for trunk and gathering pipelines	508–1,422	15.0–34.0	K52, K54, K55, K56, K60
TU 24.20.21-110-57357928-2022 Longitudinal electric-welded steel pipes for pipelines	508–1,420	7.0–48.0	K42–K60
TU 24.20.21-132-57357928-2022 Longitudinal welded steel pipes with diameters from 508 mm to 1,422 mm for pipelines	508–1,422	8.0–45.0	K42–K60
TU 24.20.22-013-53570464 Large-diameter welded steel casing pipes with diameters from 508 mm to 762 mm with welded TMK UP KATRAN HD connectors	508–762	15.9–25.4; 25.4–38.1	Pipes: X52–X70 Connectors: X80 Locking ring: X100
TU 24.20.21-010-57357928-2023 Longitudinal welded steel pipes with diameters from 508 mm to 1,420 mm	508–1,420	8.0–45.0	K42–K60
1	2	3	4

Standards	Pipes dimensions		Steel and pipes grade
	Outside diameter, mm	Wall thickness, mm	
1	2	3	4
TU 24.20.21-099-57357928-2022 Longitudinal electric-welded steel pipes of strength class K65 with outside diameter from 508 to 1420 mm of strength class K65 with outside diameter from 508 to 1420 mm with high strain capacity for gas pipelines with working pressure up to 11.8 MPa inclusive, crossing the zones of active tectonic faults (ATR), 8 MPa inclusive, crossing zones of active tectonic faults (ATF), permafrost soils (PFS) and zones of increased seismicity, as well as operated in areas with poorly bearing, sinking and subsidence soils.	508-1422	8.0-48.0	K65
TU 24.20.21-011-57357928-2023 Longitudinal electric-welded steel pipes of strength class K70 for line gas pipelines for working pressure up to and including 14.71 MPa API* Specification 5L, Line Pipe, 46th Edition	530-1420	9.9-38.1	K70
	508–1,422	7.1–48.0	A, B, X42, X46, X52, X56, X60, X65, X70, X80, L245, L290, L320, L360, L390, L415, L450, L485, L555
DNV-OS- F101 Submarine pipeline systems	508–1,422	8.0–45.0	245–555 (F, D, I)
DIN EN 10217-1:2005 Welded steel tubes for pressure purposes Part 1: Non-alloy steel tubes with specified room temperature properties	508–1,422	8.0–40.0	P195TR1, P235TR1, P265TR1, P195TR2, P235TR2, P265TR2
DIN EN 10217-3:2019 Welded steel tubes for pressure purposes Part 3: Electric welded and submerged arc welded alloy fine grain steel tubes with specified room, elevated and low temperature properties	508–1,422	8.0–40.0	P275–P460, (N, NH, NL1, NL2)
ISO 3183:2012 Steel pipe for pipeline transportation systems	508–1,422	7.92–40.0	L290 or X42, L555 or X80
ISO 3183:2019 Petroleum and natural gas industries – Steel pipe for pipeline transportation systems	508–1,422	7.0–48.0	A, B, X42, X46, X52, X56, X60, X65, X70, X80, L245, L290, L320, L360, L390, L415, L450, L485, L555
ÖNORM EN 10219-1:2006 / ÖNORM EN 10219-2:2019 Cold formed welded structural hollow sections of non-alloy and fine grain steels	508–1,422	7.0–48.0	Non-alloy steels: S235JRH, S275J0H, S275J2H, S355J0H, S355J2H, S355K2H. Fine-grain steels: S275MH–S460MLH, S275NH–S460NLH
Casing pipes with OTsK welded connectors	508	15.9	Pipes: X52, X56, X60, X65, X70 Connectors: X80 Locking ring: X100
Casing pipes with a welded pin and an OTsB shoe	508	15.9	Pipes: X52, X56, X60, X65, X70 Connectors: X80 Casing shoe body: X52, X56, X60,X65, X70
Casing crossover with a welded box connector and a pin or box	508	15.9	Pipes: X52, X56, X60, X65, X70 Connectors: X80 Locking ring: X100 Crossover pin or box: X80
TU 24.20.21-022-57357928-2024 Longitudinal electric-welded pipes made of high-alloyed corrosion-resistant steel grades	377-1620	6.0-50.0	03Kh18N11, 04Kh18N10, 08Kh18N10, 08Kh18N10T, 08Kh18N12T, 08Kh18N12S,12Kh18N9, 12Kh18N9T, 12Kh18N10T,12Kh18N12T, 03Kh17Sh4M3, 08Kh17N13M2T, 08Kh17N15M3T,10Kh17N13M2T, 20Kh23N13, 10Kh, 10Kh17N13M2T, 20Kh23N13, 10Kh23N18, 20Kh23N18, 03Kh22N5AM3, 03Kh22N6M2, 08Kh22N6T, 08Kh21N6M2T, 05KhN32T (KhN32T), 06KhN28MDT, AISI 304, 304N, 304L, 304LN, 304H, 309S, 310S, 316, 316N, 316L, 316LN, 316H, 316Ti, 317, 321, 321H, 347, 347H, 904L, 800, 318,
1	2	3	4

2.2 SAWL size ranges

Longitudinal welded LDP product range as per GOST and TU

Outside diameter, mm	Wall thickness, mm																			
	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
530																				
630																				
720																				
820																				
1020																				
1220																				
1420																				

27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46

Longitudinal welded LDP product range as per EN, ISO, and API

Outside diameter, mm	Wall thickness, mm																			
	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
508 (20")																				
559 (22")																				
610 (24")																				
660 (26")																				
711 (28")																				
762 (30")																				
813 (32")																				
914 (36")																				
1016 (40")																				
1067 (42")																				
1219 (48")																				
1422 (56")																				

27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46

Longitudinal welded double-seam LDP product range with diameters over 1,420 mm as per GOST and TU

Outside diameter, mm	Wall thickness, mm																			
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1520																				
1620																				
1720																				
1820																				
2020																				
2220																				
2420																				
2520																				

2.3 Weight per unit length (meter) as per API* Spec 5L (ASME B36.10M)

Values are given as per ASME B36.10M

Outside diameter		Wall thickness, mm									
		7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0
MM	inch*	Weight per unit length (meter), kg									
508	20	87.35	99.63	111.86	124.03	136.16	148.24	160.27	172.25	184.18	196.06
530	-	91.18	104.01	116.79	129.51	142.19	154.82	167.40	179.93	192.40	204.83
559	22	96.24	109.79	123.29	136.74	150.14	163.49	176.79	190.04	203.24	216.39
630	-	108.62	123.94	139.20	154.42	169.59	184.71	199.78	214.79	229.76	244.68
660	26	-	129.91	145.93	161.89	177.81	193.67	209.49	225.26	240.97	256.64
711	28	-	140.07	157.36	174.60	191.78	208.92	226.00	243.04	260.02	276.96
720	-	-	141.87	159.38	176.84	194.25	211.61	228.92	246.18	263.39	280.55
762	30	-	150.24	168.79	187.30	205.75	224.16	242.52	260.82	279.08	297.29
813	32	-	-	180.22	200.00	219.73	239.40	259.03	278.61	298.13	317.61
820	-	-	-	181.79	201.74	221.64	241.49	261.30	281.05	300.75	320.40
864	34	-	-	191.66	212.70	233.70	254.65	275.54	296.39	317.19	337.93
914	36	-	-	-	225.16	247.40	269.59	291.73	313.82	335.87	357.86
965	38	-	-	-	237.86	261.37	284.83	308.24	331.61	354.92	378.18
1,020	40	-	-	-	251.56	276.44	301.27	326.05	350.78	375.47	400.10
1,067	42	-	-	-	-	289.32	315.32	341.27	367.17	393.03	418.83
1,118	44	-	-	-	-	303.29	330.56	357.78	384.96	412.08	439.15
1,168	46	-	-	-	-	-	345.50	373.97	402.39	430.76	459.08
1,220	48	-	-	-	-	-	361.05	390.81	420.52	450.19	479.80
1,320	52	-	-	-	-	-	-	-	455.39	487.55	519.65
1,420	56	-	-	-	-	-	-	-	490.26	524.91	559.50

Outside diameter		Wall thickness, mm									
		27.0	28.0	29.0	30.0	31.0	32.0	33.0	34.0	35.0	36.0
MM	inch*	Weight per unit length (meter), kg									
508	20	-	-	-	-	-	-	-	-	-	-
530	-	338.26	350.09	361.87	-	-	-	-	-	-	-
559	22	357.76	370.31	382.81	-	-	-	-	-	-	-
630	-	405.50	419.83	434.10	448.32	-	-	-	-	-	-
660	26	425.68	440.75	455.77	470.73	-	-	-	-	-	-
711	28	459.98	476.31	492.60	508.84	525.03	541.17	-	-	-	-
720	-	466.03	482.59	499.10	515.57	531.98	548.34	-	-	-	-
762	30	494.27	511.88	529.44	546.95	564.41	581.82	-	-	-	-
813	32	528.57	547.45	566.28	585.06	603.79	622.47	641.10	659.68	678.21	696.69
820	-	533.28	552.33	571.33	590.29	609.19	628.04	646.85	665.60	684.31	702.96
864	34	562.86	583.01	603.11	623.16	643.16	663.11	683.01	702.86	722.66	742.42
914	36	596.49	617.88	639.23	660.52	681.77	702.96	724.11	745.21	766.25	787.25
965	38	630.78	653.45	676.06	698.63	721.15	743.61	766.03	788.39	810.71	832.98
1,020	40	667.77	691.81	715.79	739.73	763.61	787.45	811.23	834.97	858.66	882.29
1,067	42	699.38	724.58	749.74	774.84	799.90	824.91	849.86	874.77	899.63	924.43
1,118	44	733.67	760.15	786.58	812.95	839.28	865.55	891.78	917.96	944.08	970.16
1,168	46	767.30	795.02	822.69	850.31	877.88	905.40	932.88	960.30	987.67	1,014.99
1,220	48	802.27	831.28	860.25	889.17	918.03	946.85	975.62	1,004.33	1,033.00	1,061.62
1,320	52	869.51	901.02	932.48	963.89	995.24	1,026.55	1,057.81	1,089.02	1,120.17	1,151.28
1,420	56	936.76	970.76	1,004.71	1,038.61	1,072.45	1,106.25	1,140.00	1,173.70	1,207.35	1,240.95

Pipes grade: up to X80

The theoretical weight is given for single-seam pipes with a factor of 1.01 to account for weld reinforcement. In case of double-seam pipes, a factor of 1.015 is used.

17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0
207.90	219.68	231.41	243.09	254.72	266.30	277.83	289.32	300.75	-
217.21	229.54	241.82	254.05	266.23	278.36	290.44	302.47	314.45	326.38
229.49	242.54	255.54	268.49	281.39	294.25	307.05	319.80	332.50	345.16
259.55	274.37	289.14	303.86	318.53	333.15	347.72	362.24	376.71	391.13
272.25	287.82	303.34	318.80	334.22	349.59	364.91	380.17	395.39	410.56
293.85	310.68	327.47	344.21	360.90	377.53	394.12	410.66	427.15	443.59
297.66	314.72	331.73	348.69	365.60	382.47	399.28	416.04	432.75	449.41
315.44	333.55	351.61	369.61	387.57	405.48	423.34	441.15	458.90	476.61
337.04	356.41	375.74	395.02	414.25	433.42	452.55	471.63	490.66	509.64
340.00	359.55	379.05	398.51	417.91	437.26	456.56	475.82	495.02	514.17
358.63	379.28	399.88	420.42	440.92	461.37	481.77	502.12	522.42	542.67
379.80	401.69	423.54	445.33	467.07	488.77	510.41	532.00	553.55	575.04
401.39	424.56	447.67	470.73	493.75	516.71	539.63	562.49	585.31	608.07
424.68	449.22	473.70	498.13	522.52	546.85	571.13	595.37	619.55	643.69
444.58	470.29	495.94	521.54	547.10	572.60	598.06	623.46	648.82	674.12
466.18	493.15	520.07	546.95	573.77	600.55	627.27	653.95	680.57	707.15
487.35	515.57	543.74	571.86	599.93	627.95	655.92	683.84	711.71	739.53
509.36	538.88	568.34	597.76	627.12	656.44	685.70	714.92	744.08	773.20
551.71	583.71	615.67	647.57	679.43	711.23	742.99	774.69	806.35	837.96
594.05	628.54	662.99	697.38	731.73	766.03	800.27	834.47	868.62	902.71

37.0	38.0	39.0	40.0	41.0	42.0	43.0	44.0	45.0	46.0	47.0	48.0
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
715.12	733.50	751.83	770.11	-	-	-	-	-	-	-	-
721.57	740.12	758.63	777.09	-	-	-	-	-	-	-	-
762.12	781.77	801.37	820.92	-	-	-	-	-	-	-	-
808.19	829.09	849.94	870.73	-	-	-	-	-	-	-	-
855.19	877.36	899.48	921.54	-	-	-	-	-	-	-	-
905.88	929.41	952.90	976.34	-	-	-	-	-	-	-	-
949.19	973.90	998.56	1,023.16	-	-	-	-	-	-	-	-
996.19	1,022.17	1,048.09	1,073.97	-	-	-	-	-	-	-	-
1,042.27	1,069.49	1,096.66	1,123.79	-	-	-	-	-	-	-	-
1,090.19	1,118.70	1,147.17	1,175.59	-	-	-	-	-	-	-	-
1,182.34	1,213.35	1,244.31	1,275.22	-	-	-	-	-	-	-	-
1,274.50	1,308.00	1,341.44	1,374.84	1,408.19	1,441.49	1,474.74	1,507.95	1,541.10	1,574.20	1,607.25	1,640.25

2.4 Weight per unit length (meter) as per API* Spec 5L (ISO 4200)

Values are given as per ISO 4200

Outside diameter, inches	Wall thickness, mm							
	8	8.8	10	11	12.5	14.2	16	17.5
508	98.6	108	123	136	153	173	194	212
559	109	119	135	149	168	191	214	234
610	119	130	146	162	184	209	234	256
660	129	141	160	176	200	226	254	277
711	139	152	173	190	215	244	274	299
762	149	163	185	204	231	262	294	321
813	159	175	198	218	247	280	314	343
864	169	186	211	231	262	298	335	365
914	179	196	223	245	278	315	354	387
1,016	199	219	249	273	309	351	395	431
1,067	209	230	261	286	325	369	415	453
1,118	219	241	273	300	341	387	435	475
1,168	229	252	286	314	356	404	455	497
1,219	239	263	298	328	372	422	475	519
1,321	259	285	323	355	403	458	515	563
1,422	279	307	348	383	435	493	555	605

Pipes grade: up to X80

20	22.2	25	28	30	32	36	40
241	266	298	331	354	376	419	462
266	294	329	367	391	415	464	512
291	322	361	402	429	455	510	562
316	349	392	436	465	496	554	612
341	377	423	472	504	536	599	662
366	405	454	507	542	576	645	712
391	433	486	542	579	616	690	763
416	461	517	577	617	657	735	813
441	488	548	612	654	696	780	862
491	544	611	682	729	777	870	963
516	572	642	717	767	817	915	1,013
542	600	674	753	805	857	961	1,063
565	627	705	787	842	896	1,005	1,113
591	655	736	822	880	937	1,050	1,163
642	711	799	893	955	1,017	1,141	1,264
692	766	861	963	1,030	1,097	1,231	1,363

2.5 Mechanical properties of steel

Standards	Pipes dimensions		Steel grade, pipes grade	Ultimate tensile strength
	Outside diameter	Wall thickness		MPa
	mm	mm		min
1	2	3	4	5
GOST 10704-91, GOST 10706-76 Electrically welded steel line-weld tubes. Technical requirements	530–1,420 1,520– 2,520	7.0–48.0	St2kp, St2ps, St2sp, St3kp, St3ps, St3sp, low-alloy steel (CE ≤ 0.48%)	325–440
GOST 20295-85 Steel welded pipes for main gas-and-oil pipelines	530–1,420	7.0–48.0	K34, K38, K42, K48, K50, K52, K54, K55, K56, K60	333–588
GOST 31447-2012 Steel welded pipes for trunk gas pipelines, oil pipelines, and oil products pipelines	530–1,420	7.0–48.0	K34, K38, K42, K48, K50, K52, K54, K55, K56, K60	335–590
GOST 33228-2015 General purpose steel welded pipes	508–1,420 1,520– 2,520	7.0–34.0	KP175–KP460	255–590
GOST R 58064-2018 Steel welded pipes for building structures	508–1,420	8.0–48.0	C245–C440	370–540
TU 24.20.21-001-57357928-2022 Longitudinal electric-welded steel pipes of grade K60 for gas trunk pipelines with an operating pressure of 11.8 MPa and gathering gas pipelines with an operating pressure of 12.9 MPa	530–1,420	9.9–37.9	K60	590–710
TU 24.20.21-006-57357928-2022 Longitudinal electric-welded steel pipes of grade K65 with a diameter of 1,420 mm for gas trunk pipelines with an operating pressure of 11.8 MPa	1,420	23.0 27.7 33.4	K65	640–760
TU 24.20.21-012-57357928-2022 Longitudinal electric-welded steel pipes for encasements with diameters from 530 mm to 1,420 mm	530–1,420	15.2–32.0	K34–K55	335–540
TU 24.20.21-016-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 508 mm to 1,420 mm for gas trunk pipelines with an operating pressure of up to 9.8 MPa inclusive	508–1,420	7.0–32.0	K52–K60 X56–X70	490–598 590–698
TU 24.20.21-018-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 530 mm to 1,220 mm for pipelines	530–1,220	7.0–35.0	K50–K60	490–598 590–688
TU 24.20.21-020-57357928-2022 Improved low-temperature service longitudinal electric-welded steel pipes with diameters from 530 mm to 1,420 mm with enhanced weldability for use in steel structures of buildings	530–1,420	7.0–45.0	K52–K60 X56–X70	490–608 590–708
TU 24.20.21-027-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 530 mm to 1,420 mm for gas trunk pipelines with an operating pressure of up to 9.8 MPa inclusive, crossing active tectonic fault zones	530–1,420	8.0–40.0	K52, K54, K55, K56, K60, X52, X56, X60, X65, X70	460–570 590–710
TU 24.20.21-060-57357928-2022 Longitudinal electric-welded steel pipes for hydrogen sulfide service to be used in the construction and repair of pipelines in Central Asia	530–1,220	8.0–30.0	K48, K50, K52, X42, X46, X52	414–532 510–628
TU 24.20.21-061-57357928-2022 Longitudinal electric-welded steel pipes for gas gathering systems	530	16.0–26.0	K60	590–730
TU 24.20.21-067-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 508 mm to 1,422 mm for trunk and gathering pipelines	508–1,422	8.0–38.0	K52–K60 X56–X70	490–610 590–710
1	2	3	4	5

Yield strength	Relative elongation	Impact strength KCU	Impact strength KCV	Percentage of ductile fracture	Angle of bend
MPa	%	J/cm²	J/cm²	%	°grad.
min					
6	7	8	9	10	11
215–265	18–22	29–59 (+20 °C) 15-20 (+20 °C) 24 (+40 °C)			–
206–412	24–16	29.4 (–40 °C)	29.4 (–5 °C)		–
205–460	24–20	34.3–49.0 (–40 °C or –60 °C)	24.5–107.8 (–5 °C or –20 °C)	50–85 (–5 °C or –20 °C)	180
175–460	16–9	24.5–78.4 (+20 °C, –20 °C, –40 °C, –60 °C)	–	–	–
235–440	25–20	29–34 (–40 °C or –70 °C)	34–66 (0 °C, –20 °C, –40 °C, –60 °C)	–	–
485–595	20	–	V1: 100–170 (–20 °C); 63 (40 °C) V2: 110 (–19 °C) V3: 90 (–36 °C) V4: 100–225 (–42 °C)	V1: 85 (–20 °C) V2: 85 (–5 °C) V3: 85 (–20 °C) V4: 85 (–42 °C)	180
555–665	18–16	–	250 (–40°) parent met., 70 (–40°) weld. joint	85 (–20 °C)	180
205–390	22–17	24.5 (–40 °C or –60 °C)	–	–	–
360 485	20	39.2–58.8 (–60 °C)	39.2–107.8 (–20 °C)	50–85 (–20 °C)	180
345 460	20	49–74 (–60 °C or –40 °C)	49–88 (–20 °C or –5 °C)	60–80 (–20 °C or –5 °C)	120
360 485	20	–	34 (–40 °C)	–	180
355–455 485–595	21–20	59 (–60 °C)	80–150 (–40 °C)	85 (–20 °C)	180
265 359	20	49 (–60 °C)	49 (–20 °C)	60 (–20 °C)	180
485–605	20	39.2 (–60 °C)	39.2 (–50 °C)	50 (–20°C)	180
355 485	20–18	50–60 (–60 °C or –40 °C)	cat. C: 60–80 (–5 °C) cat. C: 85–130 (–20 °C, –30 °C, –40 °C) cat. E: 100–170 (–40 °C)	cat. C: 85 (–5 °C) cat. C: 85 (–20 °C, –30 °C, –40 °C) cat. E: 85 (–40 °C)	180
6	7	8	9	10	11

Standards	Pipes dimensions		Steel grade, pipes grade	Ultimate tensile strength
	Outside diameter	Wall thickness		MPa
	mm	mm		min
1	2	3	4	5
TU 24.20.21-068-57357928-2022 Longitudinal electric-welded steel pipes for unique building structures	508–1,420	7.0–45.0	C345–C440, K52–K60, X56–X70	470–590 590–710
TU 24.20.21-074-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 530 mm to 820 mm for trunk and gathering pipelines	530–820	8.0–12.0	K52–K60, X56–X70	490–610 590–710
TU 24.20.21-076-57357928-2022 Longitudinal electric-welded steel pipes for gathering pipelines with an operating pressure of up to 24.0 MPa inclusive	508	22.2 23.8 24.9	X65, SAWL 450 IFD	535–655
TU 1381-079-00186654-2016 Longitudinal electric-welded steel pipes of carbon or low-alloy steel for steam and hot water pipelines	530–1,420	8.0–25.0	St3sp, 20, 09G2S, 17GS, 17G1S, 17G1S-U	370–480 510–660
TU 24.20.21-1573-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 530 mm to 1,420 mm and wall thicknesses of up to 32 mm for gas, oil, and petroleum product trunk pipelines	530–1,420	8.0–32.0	12G2S, 09G2S, 17GS, 17G1S, 17G1S-U, 13GS, 13GS-U, 08GBYu, 12GSB, 09GSF, 13KhFA, 13G1S-U, 12G2SB, 09GBYu, 09G2FB, 10G2FBYu, 08G1NFB (pipe grades K50, K52, K54, K55, K56, K60)	490–608 590–708
TU 14-156-78-2008 Longitudinal electric-welded steel pipes with diameters from 530 mm to 1,420 mm for gas trunk pipelines with an operating pressure of 11.8 MPa	530–1,420	9.9–37.9	K60	590
TU 24.20.22-201-57357928-2022 Longitudinal electric-welded steel pipes of grade K65 with a diameter of 1,420 mm for gas trunk pipelines with an operating pressure of 11.8 MPa	1,420	23.0, 27.7	K65	640
TU 14-156-98-2013	530–1,220	14.2–33.0	K60	560–710
TU 24.20.21-206-57357928-2022 Highly corrosion-resistant, improved low-temperature service longitudinal electric-welded steel pipes for pipelines	530–1,220	8.0–30.0	K48, K50, K52, K54, K55, K56, K60	471–710
TU 24.20.21-203-57357928-2022 Longitudinal electric-welded steel pipes for gas trunk pipelines with an operating pressure of up to 9.8 MPa (100 kgf/cm ²) inclusive, operated in active tectonic fault zones, in earthquake-prone areas, and in permafrost zones	530–1,420	10.0–36.0	K52, K54, K55, K56, K60, X52, X56, X60, X65, X70	440–710
TU 24.20.21-202-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 530 mm to 1,420 mm for trunk and gathering pipelines with an operating pressure of up to 10.0 MPa inclusive	530–1,420	8.0–32.0	K52, K54, K55, K56, K60, K65, X56, X60, X65, X70, X80	510–760
TU 24.20.21-205-57357928-2022 Longitudinal electric-welded steel pipes with outside diameters from 530 mm to 1,220 mm for underwater gas pipelines	530–1,220	8.0–32.0	SMYS 245–485 F, D	370–570
TU 24.20.21-207-57357928-2022 Longitudinal electric-welded steel pipes for pipelines	530–1,420	8.0–36.0	K42–K60, V1, 2	415–760
			K34–K60, V3	310–570
1	2	3	4	5

Yield strength	Relative elongation	Impact strength KCU	Impact strength KCV	Percentage of ductile fracture	Angle of bend
MPa	%	J/cm ²	J/cm ²	%	°grad.
min					
6	7	8	9	10	11
345 440	20	–	60–100 (–20 °C, –40 °C, –60 °C)	80 (–20 °C)	180
355 485	20–18	50–60 (–60 °C or –40 °C)	cat. C: 60–70 (–5 °C) cat. C: 85–105 (–20 °C, –30 °C, –40 °C)	cat. C: 85 (–5 °C) cat. C: 85 (–20 °C, –30 °C, –40 °C)	180
450–570	20	–	155 (–32 °C)	85 (–10 °C)	180
235 360	23–20	29–44 (–20 °C or –40 °C)	–	–	120/180
340–470 460–600	20	29.4–49.0 (–40 °C or –60 °C)	29.4–49.0 (0 °C, –5 °C, –15 °C, –20 °C, –40 °C)	50–60 (0 °C, –5 °C, –15 °C, –20 °C)	120/180
485	20	–	100–170 (at +20 °C)	85 (at +20 °C)	180
555	18	–	250 (at +40 °C)	85 (at +20 °C)	180
485–595	20	–	80–110	85	180
295–460	20	34.3–44.1	39.2	50	180
355–585	20–21	60	100–110	85	180
355–555	18–20, 18–20	40–50	85–130 (K52–K60), 160–250 (K65)	85	180
245–485	18–22		40.0–136.0	85	180
290–635	18–20	45.0 (at –40 °C and –60 °C)	50.0 (at –20 °C)	50	180
175–485	18–20	39.2 (at –20 °C) 24.5 (at –40 °C and –60 °C)	50.0 (at –20 °C)	50	
6	7	8	9	10	11

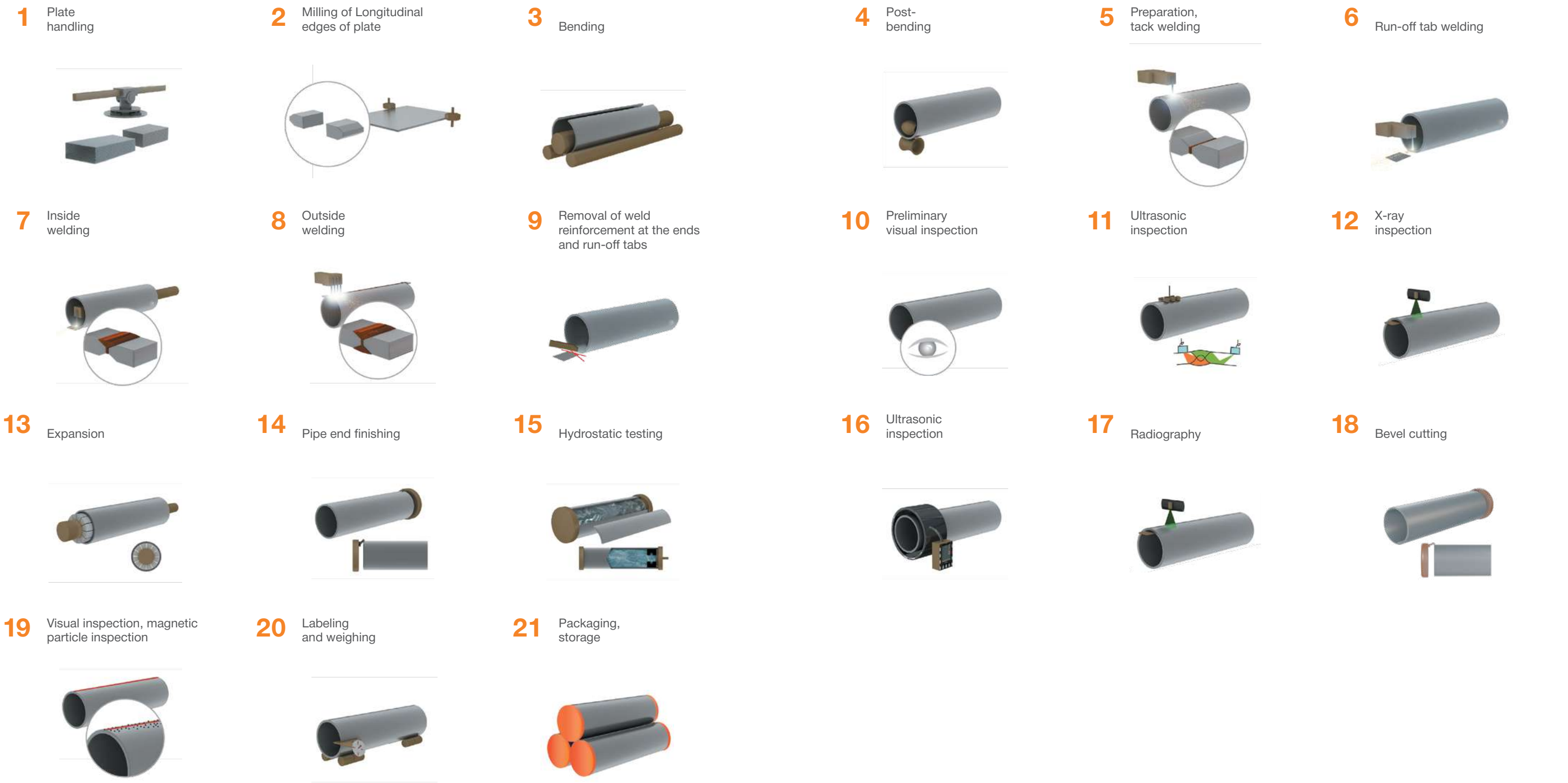
Standards	Pipes dimensions		Steel grade, pipes grade	Ultimate tensile strength
	Outside diameter	Wall thickness		MPa
	mm	mm		min
1	2	3	4	5
TU 14-158-136-2007 Highly corrosion-resistant, improved low-temperature service longitudinal electric-welded pipes of 20 and 20KSKh steel for oil and gas pipelines	530–1,220	7.0–22.0	20, 20KSKh	510–630
TU 14-158-153-05 (double-seam modification) Longitudinal electric-welded steel pipes with a diameter of 1,020 mm/1,220 mm for gas and oil pipelines	1,020, 1,220	10.0–22.0	17G1S-U, 09GSF, 13GS, 13GSU, 13G1SU, 12GSB, 12G2SB, 08G1NFBYu, 10G2FBYu, grades K52–K60	510–630 590–690
TU 14-3P-1270-2009 Longitudinal electric-welded steel pipes with a diameter of 530 mm, 720 mm, or 820 mm for gas and oil trunk pipelines	530–820	7.0–15.0	17GS, 17G1S, 17G1S-U, 13GS, 13GSU, 13G1SU, 08GBYu, 09GBYu, 12GSB, 12G2SB, 08G1NFBYu, 10G2FBYu, 09GSF, grades K52–K60	510–628 590–708
TU 24.20.21-164-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 508 mm to 1,422 mm	508–1,422	7.5–48.0	L360–L485, 09GSF, 05KhGB, 13KhFA	460–760 570–760
TU 24.20.21-021-57357928-2022 Longitudinal electric-welded steel pipes for onshore and offshore gathering pipelines	508, 514, 813, 820	27.0, 30.1, 30.2, 32.2, 38.7, 40.8, 45.8, 46.8	K60, X65, 450 I FD	535–655 590–710
TU 24.20.21-039-57357928-2022 Longitudinal electric-welded steel pipes for underwater pipelines	508–1,220	8.0–41.0	X60, X65, X70, SAWL 415 IFD, SAWL 450 IFD, SAWL 485 IFD	520 570
TU 24.20.21-077-57357928-2022 Longitudinal electric-welded steel pipes with diameters from 508 mm to 1,422 mm for use in a wide temperature range from minus 60 °C to plus 400 °C	508–1,422	8.0–40.0	K50–K60 X56–X70	490–610 590–710
TU 24.20.21-102-57357928-2022 Highly corrosion-resistant, high-reliability, longitudinal electric-welded steel pipes for pipelines	530–1,420	7.0–40.0	09GSF, 13KhFA	510–630
TU 24.20.21-103-57357928-2022 Low-temperature service longitudinal steel pipes for pipelines	530–1,420	7.0–40.0	K48–K60	471–591 590–710
TU 24.20.21-106-57357928-2022 Longitudinal electric-welded steel pipes for pipelines with an operating pressure of up to 24.0 MPa inclusive	508–812.8	24.9–39.0	K60, X70	590–710
TU 24.20.21-108-57357928-2022 Longitudinal welded steel pipes with diameters from 508 mm to 1,422 mm made using laser-hybrid welding for trunk and gathering pipelines	508–1,422	15.0–34.0	K52–K60	510–630 590–710
TU 24.20.21-110-57357928-2022 Longitudinal electric-welded steel pipes for pipelines	508–1,420	7.0–48.0	K42–K60	310 570–760
TU 24.20.21-132-57357928-2022 Longitudinal welded steel pipes with diameters from 508 mm to 1,422 mm	508–1,422	8.0–45.0	K42–K60	410 590
TU 24.20.21-019-57357928-2022 Large-diameter casing pipes with diameters from 508 mm to 914 mm with LYNX SA2 and LYNX HDHT welded connectors	508–914	12.7–38.1	K48–K60 X52–X70	460–570 590–710
TU 24.20.21-010-57357928-2023 Longitudinal welded steel pipes with diameters from 508 mm to 1,420 mm	508–1,420	8.0–45.0	K42–K60	410–590
1	2	3	4	5

Yield strength	Relative elongation	Impact strength KCU	Impact strength KCV	Percentage of ductile fracture	Angle of bend
MPa	%	J/cm²	J/cm²	%	°grad.
min					
6	7	8	9	10	11
343	20	39.2 (–60 °C)	39.2 (–20 °C)	50 (–20 °C) in impact test pieces	180
360 480	20	39.2–49.0 (–40 °C, –60 °C)	29.4–58.8 (0 °C, –15 °C, –20 °C)	50–70 (0 °C, –15 °C, –20 °C)	180
353 460	20	39.2 (–40 °C, –60 °C)	39.2 (–5 °C, –20 °C)	50–70 (0 °C, –15 °C, –20 °C)	–
360–530 485–635	20	60 (–60 °C, –70 °C)	50 (–60 °C)	85 (–20 °C) 50 (–60 °C) in impact test pieces	180
450–570	20–18	–	V1: 200 (–40 °C) V2: 155–225 (–25 °C, –30 °C)	85 (–10 °C)	180
415 485	18	–	42–50 (–20 °C, –40 °C)	85 (–20 °C)	180
345 485	20–18	60 (–60 °C)	80–180 (–20 °C, –30 °C, –40 °C, –50 °C, –60 °C)	85 (–20 °C, –40 °C)	180
353	20	34.3–44.1 (–60 °C)	39.2 (–20 °C)	50 (–20 °C) in impact test pieces	180
334 460	20	34.3–44.1 (–60 °C)	39.2 (–20 °C)	50 (–20 °C) in impact test pieces	180
485–605	20–18	150 (–60 °C)	150 (–40 °C, –43 °C)	85 (–20 °C, –24 °C)	180
355 485	20	60 (–60 °C)	85–130 (–20 °C)	85 (–20 °C)	180
175485–635	20–18	24.5–45.0 (from –20 °C to –60 °C)	59–118 (–20 °C)	50 (–20 °C) in impact test pieces	120/180
245 460	20–16	29.4–59.0 (–40 °C)	39.2–59 (–20 °C, –40 °C)	50 (–20 °C) in impact test pieces	180
355 485	20–18	50–60 (–40 °C, –60 °C)	cat. C: 60–80 (–5 °C) cat. C: 85–130 (–20 °C, –30 °C, –40 °C) cat. E: 100–170 (–40 °C)	cat. C: 85 (–5 °C) cat. D: 85 (–20 °C, –30 °C, –40 °C) cat. E: 85 (–40 °C)	180
245–460	20–16	39.2–59.0 (–60 °C)	34.0–59.0 (–20 °C, –40 °C, –60 °C)	50 (–40 °C) in impact test pieces	120/180
6	7	8	9	10	11

Standards	Pipes dimensions		Steel grade, pipes grade	Ultimate tensile strength
	Outside diameter	Wall thickness		MPa
	mm	mm		min
1	2	3	4	5
TU 24.20.21-099-57357928-2022 Longitudinal electric-welded steel pipes of strength class K65 with outside diameter from 508 to 1420 mm with high strain capacity for gas pipelines with working pressure up to and including 11.8 MPa, crossing zones of active tectonic faults (ATF), permafrost soils (PFS) and zones of increased seismicity, as well as operated in areas with poorly bearing, sinking and subsidence soils	508-1422	8.0-48.0	K65	650-760
TU 24.20.21-011-57357928-2023 Longitudinal electric-welded steel pipes of strength class K70 for line gas pipelines with working pressure up to and including 14.71 MPa	530-1420	9.9-38.1	K70	700-850
ISO 3183-2019 / API* 5L 46th edition Petroleum and natural gas industries	508–1,422	7.1–48.0	B, X42–X80, L245–L555	415–655 625–825
ÖNORM EN 10219-1:2006 / ÖNORM EN 10219-2:2019 Cold formed welded structural hollow sections of non-alloy and fine grain steels	508–1,422	7.0–48.0	Non-alloy steels: S235JRH, S275J0H, S275J2H, S355J0H, S355J2H, S355K2H Fine-grain steels: S275MH–S460MLH, S275NH–S460NLH	Non-alloy steels: 360–510, 470–630 Fine-grain steels: 370–510, 540–720
TU 24.20.21-022-57357928-2024 Longitudinal electrically welded pipes made of high-alloyed corrosion-resistant steel grades	377-1620	6.0-50.0	03Kh18N11, 04Kh18N10, 04Kh18N10, 08Kh18N10, 08Kh18N10, 08Kh18N10T, 08Kh18N10T, 08Kh18N12T, 08Kh18N12T, 08Kh18N12B, 08Kh18N12B, 12Kh18N9, 12Kh18N9T, 12Kh18N9T, 12Kh18N10T, 12Kh18N10T, 12Kh18N12T, 12Kh18N12T, 03Kh17Sh4M3, 03Kh17Sh4M3, 08Kh17N13M2T, 08Kh17N13M2T, 08Kh17N15M3T, 08Kh17N15M3T, 10Kh17N13M2T, 10Kh17N13M2T, 20Kh23N13, 10Kh23N18, 10Kh23N18, 20Kh23N18, 20Kh23N18, 03Kh22N5AM3, 03Kh22N6M2, 08Kh22N6T, 08Kh21N6M2T, 05KhN32T (KhN32T), 06KhN28MDT, AISI, 304, 304N, 304L, 304LN, 304H, 309S, 310S, 316, 316N, 316L, 316LN, 316H, 316Ti, 317, 321, 321H, 347, 347H, 321H, 347, 347H, 904L, 800, 318, 2205	
1	2	3	4	5

Yield strength	Relative elongation	Impact strength KCU	Impact strength KCV	Percentage of ductile fracture	Angle of bend
MPa	%	J/cm²	J/cm²	%	°grad.
min					
6	7	8	9	10	11
555-665	18-19	60	160-250	85	180
600-750	16	-	250-320	85	180
245–450 555–705	per spec.	–	per spec.	per spec.	180
Non-alloy steels: 225 355 Fine-grain steels: 265 460	Non-alloy steels: 24–20 Fine-grain steels: 24–17	–	Non-alloy steels: 27–40 J (+20 °C, 0 °C, –20 °C) Fine-grain steels: 27–40 J (–20 °C, –50 °C)	–	–
6	7	8	9	10	11

2.6 SAWL pipe production process (TMK PS, Volzhsky)



2.7 SAWL pipe production process
("Vysota 239", TMK PS, Chelyabinsk)



2.8 SAWL pipe production process at 530-820 mm pipe mill
(TMK PS, Chelyabinsk)



2.9 SAWL pipe production process at 1020-1220 mm pipe mill
(TMK PS, Chelyabinsk)





PRODUCTION OF LONGITUDINAL WELDED LDP OF COIL STEEL WITH HFC INDUCTION WELDING

Production of longitudinal welded LDP of coil steel with HFC induction welding is located at Seversky Pipe Plant in Polevskoy, Sverdlovsk Region. The JV products are intended to meet the needs of oil and gas companies in Russia and the CIS using Longitudinal electric-welded pipes for oil and gas production and transportation, as well as the growing demand of the construction industry.

3.1 Table of standards

Standards	Pipes dimensions		Pipes grade
	Outside diameter, mm	Wall thickness, mm	
1	2	3	4
API* 5L/ISO 3183-2019 Specification for line pipes. PSL-1	508	6.35–11.91	A, B, X42
DIN EN 10217-1 Welded steel tubes for pressure purposes.	508	6.3–11.0	P235TR1, P265TR1
DIN EN 10219-1 and 10219-2 Cold formed welded structural hollow sections of non-alloy and fine grain steels	508	6.0–12.0	S235JRH, S275J0H, S275J2H S355J0H, S355J2H
GOST 10704/10705 Electrically welded steel tubes	530	7.0–12.0	St.2, St.3, 10, 20, 22GYu, 09G2S, 17G1S, 17G1S-U
GOST 20295-85 Steel welded pipes for main gas-and-oil pipelines. Technical requirements	530	7.0–12.0	K34, K38, K42, K48, K50, K52
TU 14-162-173-2019 LSAW pipes for field, technological and general purpose pipelines for oil and gas fields	530	7.0–12.0	K34, K38, K42, K46, K50, K52
TU 14-162-174-2020 LSAW pipes for oil and gas pipelines	530	7.0–12.0	K42, K46, K50, K52
TU 14-162-180-2022 LSAW pipes for oil and gas fields	530	7.0–12.0	20A, 09G2S, 17G1S-U
1	2	3	4

3.2 Medium diameter welded pipe production process





EXTERNAL PIPE COATING

TMK PS can apply the following types of external anti-corrosion pipe coating (including):

- Two-layer PE coating
- Three-layer PE and PP coating
- Single layer PE coating
- Single and two-layer epoxy coating
- External protective coating

The coatings are applied to the external surface of welded and seamless pipes with diameters from 114 mm to 1,420 mm
Operating temperature of pipes: from -60°C to $+80^{\circ}\text{C}$
(for PE coating) or from -20°C to $+110^{\circ}\text{C}$ (for PP coating).

4.1 External anti-corrosion coating standards

Standards	Purpose of coating
1	2
GOST 31448-2012 Steel pipes with defensive coverings for main gas and oil pipelines	Construction and repair of trunk gas, oil, and petroleum product pipelines
GOST R 51164-98 Steel pipe mains. General requirements for corrosion protection	Corrosion protection of the external surfaces of steel trunk pipelines above and below ground
GOST 9.602-2016 Underground constructions. General requirements for corrosion protection	Corrosion protection of the surfaces of steel structures: pipelines transporting natural gas (trunk or distribution pipelines), crude oil or petroleum products, and branch lines thereof; water pipelines; piles, plate piles, columns, and other load-bearing below-grade steel structures
TU 24.20.13-003-57357928-2022 Seamless and welded steel pipes with diameters from 219 mm to 1,420 mm inclusive, with an external three-layer extruded polyethylene protective coating	Construction, retrofit, and major repair of underground and underwater trunk pipeline facilities. For encasements used in the construction of trunk pipeline crossings through natural and man-made obstacles
TU 24.20.13-118-57357928-2022 Steel pipes with external protective polyethylene coating	Construction, retrofit, and major repair of underground and aboveground pipeline facilities and crossings constructed by directional drilling through natural and man-made obstacles
TU 24.20.13-045-57357928-2022 Steel pipes with external anti-corrosion polypropylene coating	Construction, retrofit, and major repair of high-temperature sections of underground gas pipelines and branches thereof, high-temperature process gas pipelines, and offshore (subsea) sections of gas pipelines as well as of sections of gas pipelines constructed by directional drilling
TU 24.20.13-160-57357928-2022 Steel pipes with external protective polyethylene coating	Construction, retrofit, and repair of underground and aboveground gathering pipelines for oil, gas, and gas condensate fields
TU 24.20.13-223-57357928-2022 Seamless and welded steel pipes with diameters from 114 mm to 1,420 mm and external protective polyethylene coating	Construction, retrofit, and major repair of underground and underwater trunk pipeline facilities. For encasements used in the construction of trunk pipeline crossings through natural and man-made obstacles
TU 24.20.13-222-57357928-2022 Electric-welded or seamless steel pipes with external anti-corrosion polypropylene coating	Construction, retrofit, and major repair of high-temperature sections of underground gas pipelines and branches thereof, high-temperature process gas pipelines, and offshore (subsea) sections of gas pipelines as well as of sections of gas pipelines constructed by directional drilling
TU 24.20.13-014-57357928-2022 Steel pipes with external anti-corrosion polyethylene coating for gas pipelines	Construction, retrofit, and major repair of underground and offshore (subsea) gas pipelines and branches thereof, as well as sections of gas pipelines constructed by directional drilling
TU 24.20.13-220-57357928-2022 Steel pipes with external anti-corrosion polyethylene coating for gas pipelines	Construction, retrofit, and major repair of underground and offshore (subsea) gas pipelines and branches thereof, as well as sections of gas pipelines constructed by directional drilling
1	2

Standards	Purpose of coating
1	2
TU 24.20.13-225-57357928-2022 Steel pipes with diameters from 114 mm to 1,420 mm and external extruded polyethylene coating	Construction of gathering and process pipelines, general purpose pipelines, underground, underwater, and aboveground (in a mound) pipelines and branches thereof
TU 24.20.13-226-57357928-2022 Seamless and welded steel pipes with an external protective extruded polyethylene coating for offshore gathering and trunk pipelines	Construction of gathering and trunk oil and gas pipelines. Underwater pipeline protection against external corrosion
TU 24.20.13-148-57357928-2022 External two-layer epoxy pipe coating	Construction, retrofit, and major repair, and for pipes used as encasements with a diameter of up to 1,420 mm inclusive
TU 24.20.13-007-57357928-2023 Steel pipes with external anti-corrosion epoxy coating for pipeline transportation systems for liquids and gas	Construction of pipeline transportation systems for liquids and gas
TU 24.20.13-008-57357928-2023 Steel pipes with external anti-corrosion polyethylene coating for pipeline transportation systems for liquids and gas	Construction of pipeline transportation systems for liquids and gas
DIN 30670:2012 Polyethylene coatings on steel pipes and fittings – Requirements and testing	Protection of buried or submerged steel pipelines
DIN 30678:2013 Polypropylene coatings on steel pipes and fittings – Requirements and testing	Protection of buried or submerged pipelines at temperatures from minus 20 °C to 110 °C
ISO 21809-1:2018 Petroleum and natural gas industries External coatings for buried or submerged pipelines used in pipeline transportation systems Part 1: Polyolefin coatings (3-layer PE and 3-layer PP)	Corrosion protection of welded and seamless steel pipes for pipeline transportation systems in the petroleum and natural gas industries
TU 24.20.13-056-57357928-2022 Steel pipes with external anti-corrosion single-layer epoxy coating	Designed for further application of foamed polyurethane thermal insulation in a protective sheath and for the construction, retrofit, and repair of trunk, petroleum-product, gathering, and process pipelines, pump and compressor stations, and other gas industry facilities
TU 24.20.13-123-57357928-2022 Steel pipes with external anti-corrosion epoxy coating	Construction, retrofit, and major repair of underground and aboveground (in a mound) pipelines, for encasements used in the construction of pipeline crossings through natural and man-made obstacles as well as for further application of foamed polyurethane thermal insulation in a protective sheath
TU 24.20.13-158-57357928-2022 Steel pipes with external anti-corrosion epoxy coating	Construction, retrofit, and major repair of underground and aboveground (in a mound) pipelines, for encasements used in the construction of pipeline crossings through natural and man-made obstacles as well as for further application of foamed polyurethane thermal insulation in a protective sheath
1	2

4.2 Process for external coating application

1 Pipe incoming inspection
(visual)



2 Preheating
in a gas furnace



3 Wheel blasting of pipe external
surface



4 Pipe internal surface purging
to remove dust



5 Quality control of pipe surface
preparation
(visual)



6 Heating. Chromating.
Subsequent heating before coating



7 a Two-layer PE or PP coating
1) Adhesive application
2) Application of polyethylene
(or propylene)



7 b Three-layer PE or PP coating
1) Epoxy primer application
2) Adhesive application
3) Application of polyethylene
(or polypropylene)



8 Water cooling of coated pipes



9 Holiday testing



10 Removal of coating from
pipe ends



11 Final quality control
of coated pipes
(visual)



12 Pipe labeling. Installation
of protective parts. Pipe storage



4.3 Anti-corrosion coating properties
Three-layer extruded polyethylene coating

Property	Parameters
1. Minimum thickness, μm	
1 st layer	100–250
2 nd layer	150–400
Total thickness	2,000-4,000 (depending on requirements)
2. Cut-back length, mm	80–180
coating bevel, deg.	20–45
3. Adhesive strength, N/cm width	
at t +20 \pm 5 °C	250
at t +80 \pm 3 °C	100
4. Maximum indentation resistance, mm	
at t +25 \pm 2 °C	0.2
at t +80 \pm 3 °C	0.3
5. Minimum impact strength, J	
at t +23 \pm 2 °C	18
6. Elongation at break, %	
minimum, at t –45 \pm 5 °C	100
7. Cathodic disbonding of coatings, maximum, cm^2	4
8. Degree of cure of epoxy primer	$-2 < \Delta T_g < +3$

INTERNAL PIPE COATING

TMK PS can apply the following types of pipe internal coating:

- Internal flow coating
- Protective

Internal coating can be applied both before and after external coatings.

Internal flow coating is designed to increase throughput as a result of lower loss in transit and to protect the internal surface from atmospheric corrosion during pipe transportation, storage and installation. The coating is applied to pipe with diameters from 530 mm to 1,422 mm.

Allowable ambient temperatures for continuous gas pipeline operation range from -20°C to $+80^{\circ}\text{C}$.

Protective internal coating is designed to protect the internal surface of pipes used in water pipelines (including drinking water pipelines), agricultural water supply and sewage systems from corrosion.

The coating is applied to pipes with diameters from 530 mm to 1,422 mm. Allowable ambient temperatures for continuous pipeline operation range from $+5^{\circ}\text{C}$ to $+60^{\circ}\text{C}$.

5.1 Standards. Coating properties

Standards	Purpose of coating
GOST 9.602-2016 Underground constructions. General requirements for corrosion protection, incl. as per GOST 31445	Corrosion protection of the external surfaces of underground steel trunk pipelines (including buried offshore pipelines)
TU 24.20.13-227-57357928-2022 Electric-welded steel pipes with internal anti-corrosion coating for water pipelines	Construction, retrofit, and major repair of water pipelines, agricultural water supply pipelines, and sewage systems. Corrosion protection of the internal surfaces of pipelines
TU 24.20.13-005-57357928-2022 Electric-welded steel pipes with internal flow coating for the construction of gas trunk pipelines	Construction, retrofit, and major repair of subsea gas pipelines. Coating is intended for drag reduction in gas pipelines as well as for the protection of the internal surfaces of pipes against atmospheric corrosion during transportation, storage, and installation
TU 1390-017-00186654-2009 Electric-welded steel pipes with diameters from 530 mm to 1,420 mm with internal anti-corrosion coating for water pipeline construction	Construction, retrofit, and major repair of underground and underwater water pipelines, including for drinking water, with an operating temperature of up to plus 60 °C
TU 24.20.13-221-57357928-2022 Electric-welded steel pipes with internal flow coating for gas trunk pipelines	Construction, retrofit, and major repair of gas pipelines and branches thereof
TU 24.20.13-072-57357928-2022 Electric-welded steel pipes for the oil industry with internal anti-corrosion coating	Construction, retrofit, and major repair of oil gathering pipelines
TU 24.20.13-112-57357928-2022 Electric-welded steel pipes with internal anti-corrosion coating	Construction, retrofit, and repair of gathering, process, and on-site pipelines
TU 24.20.13-166-57357928-2022 Steel pipes with internal anti-corrosion coating	Construction, retrofit, and repair of underground and aboveground (in a mound) gathering pipelines for oil, gas, and gas condensate fields
TU 24.20.13-004-57357928-2023 Electric-welded steel pipes with internal anti-corrosion coating for pipeline transportation systems for liquids and gas	Construction and retrofit of pipeline transportation systems for liquids and gas
API* RP 5L2-2002 (2015) Recommended Practice for Internal Coating of Line Pipes for Non-corrosive Gas Transmission Service (flow coating)	For non-corrosive gas transmission. Coating is intended for drag reduction in gas pipelines as well as for the protection of the internal surfaces of pipes against atmospheric corrosion during transportation, storage, and installation
DIN EN 10301 Internal coating for the reduction of friction for conveyance of non corrosive gas	For the reduction of friction of tubes and pipeline fittings for conveyance of non corrosive gas

Coating properties

Internal Flow Coating

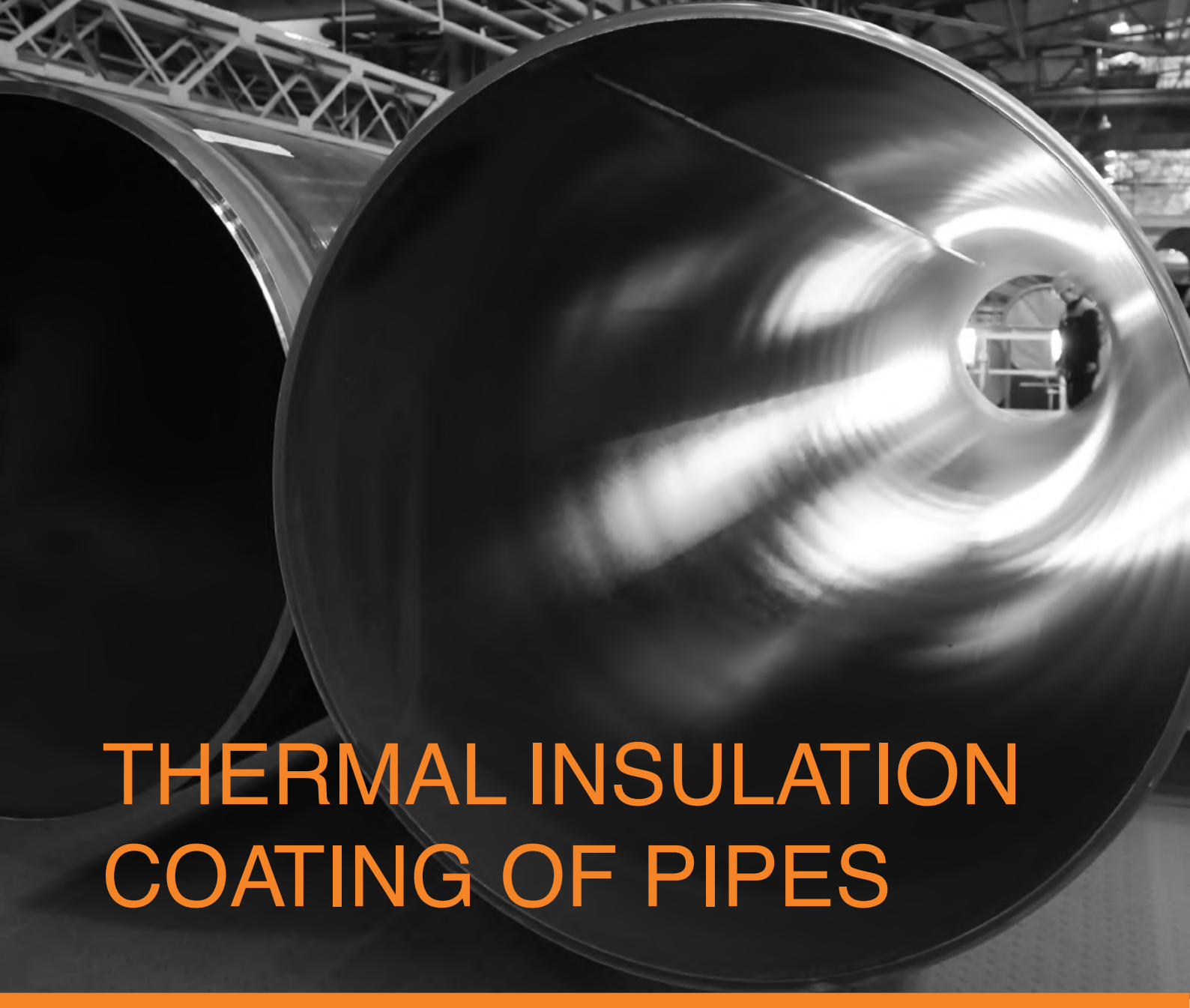
Property	Unit of measurement	Norm
1. Thickness of cured coating	µm	60–150
2. Cross-cut test of coating adhesion, maximum	points	1
3. Maximum adhesion of coating after holding for 240 hours in water at (20±5) °C as determined by the cross-cut test	points	2
4. Maximum coating resistance to bending	mm	10
5. Minimum Buchholz hardness	hardness units	94
6. Maximum number of pores in the coating a) uncured b) cured	pores/cm²	0 1
7. Coating resistance to changes in gas pressure	–	No bubbles or damage after the 10 th cycle
8. Coating resistance to changes in hydraulic pressure	–	No bubbles or damage after the 1 st cycle
9. Resistance against exposure to salt spray at (25±3) °C for 240 hours	–	Absence of bubbles and peeling
10. Maximum coating roughness (Rz)	µm	15

Protective coating

Property	Unit of measurement	Norm
1. Minimum thickness of cured coating	µm	250–400 (depending on requirements)
2. Determination of adhesion by X-cut test method	points	0 or 1
3. Pull-off test for adhesion, minimum	kgf/cm²	50
4. Degree of cure of coating	–	No softening or washout
5. Resistance against exposure to 1% solution of NaOH and/or H2SO4 at (24±3) °C for 30 days	–	No blistering or peeling
6. Resistance against exposure to water at (24±5) °C for 30 days	–	No blistering or peeling

5.2 Internal coating application process





THERMAL INSULATION COATING OF PIPES

TMK PS (Chelyabinsk) can apply thermal insulation coating to the following types of pipes:

- Pipes made of galvanized steel for aboveground and cased pipelines
- Pipes made of steel with polymer coating for underground pipelines
- Pipes made of polyethylene for underground and aboveground pipelines

Thermal insulation coating maintains the product temperature to prevent heat loss and negative impact of elevated temperatures on the environment.

Pipes with thermal insulation made of PU foam can be provided with inserts preventing the spread of fire, sensor wires for surveillance

systems and tubes for an induction-resistance heating system.

Allowable ambient temperature for handling thermally insulated products:

- During transportation, storage and operation for pipes made of galvanized steel or steel with polymer coating: -60°C to +60°C, for pipes made of polyethylene: -20°C to +60°C
- During loading and unloading, construction and installation for pipes made of galvanized steel or steel with polymer coating: -50°C to +60°C, for pipes made of polyethylene: -20°C to +60°C

6.1 Standards. Coating properties

Standards	Purpose of coating
GOST 30732-2020 Steel pipes and shaped products with foamed polyurethane thermal insulation in protective sheath	For underground heat networks (uncased, in ducts impassable for people or in crawl space; or, when steel galvanized sheath is provided, in service ducts or tunnels) or aboveground heating networks (hereinafter referred to as “insulated pipes and fittings”) with the following design parameters of heat transfer medium (superheated water): operating pressure as per the design documentation and temperature of up to 150 °C, with heat supply control range of 150 °C to 70 °C
TU 23.99.19-055-57357928-2022 Steel pipes and connection elements with foamed polyurethane thermal insulation in a protective sheath	Construction, retrofit, and repair of trunk, petroleum-product, gathering, and process pipelines, pipelines of pump and compressor stations, and other gas industry facilities
TU 23.99.19.111-062-00186654-2018 Steel pipes and shaped products with foamed polyurethane thermal insulation in a protective sheath (as per GOST 30732)	For underground heat networks (uncased, in ducts impassable for people or in crawl space), for aboveground heat networks, heat networks in service ducts or in tunnels with the following design parameters of heat transfer medium (superheated water): an operating pressure of no more than 1.6 MPa and a temperature of no more than 150 °C
TU 23.99.19-125-57357928-2022 Steel pipes and connection elements with foamed polyurethane thermal insulation in a protective sheath	Construction, retrofit, and repair of gathering and process pipelines, general purpose pipelines, and other oil and gas production facilities
TU 24.20.13-161-57357928-2022 Steel pipes and connection elements with foamed polyurethane thermal insulation in a protective sheath	Construction, retrofit, and repair of gathering and process pipelines, general purpose pipelines, and other oil and gas production facilities
TU 24.20.13-009-57357928-2023 Steel pipes and connection elements with foamed polyurethane thermal insulation in a protective sheath for pipeline transportation systems for liquids and gas	Construction of pipeline transportation systems for liquids and gas

Properties of PU foam thermal insulation

Property	Value
1. Appearance	Rigid cellular plastic of light yellow to light brown color with a uniform fine-cell structure
2. Minimum apparent density, kg/m³	60
3. Minimum compressive strength at 10% deformation in radial direction, MPa	0.3
4. Maximum thermal conductivity at (50±3) °C, W/m·K	0.033
5. Maximum water absorption in a 90-minute boiling test, vol%	10
6. Minimum axial shear strength at (23±2) °C, MPa	0.12
7. Minimum tangential shear strength at (23±2) °C, MPa	0.2

A complete list of tests and testing methods can be found in applicable technical standards.

6.2 Thermal insulation application process



API* - Effective March 17, 2022, the API Monogram/APIQR Program has ceased offering certification services within the Russian Federation in response to restrictions on financial and business activities imposed by the U.S. and Russian governments. As a result, now all TMK facilities are not authorized to apply the API Monogram on their products.

TMK facilities were holding API license continuously for over 25 years. They have vast experience of manufacturing material in accordance with API standards to the clients worldwide. Since 2003, the TMK facilities have produced more than 3 million metric tons of casing, tubing, drilling and linepipes as per API Standards and marked with the API monogram.

TMK product's quality and reliability are demonstrated by years of supply and service customers.

However, now the TMK facilities are still permitted to state that their products meet or comply with an API standard or specification provided that they do meet the requirements in the API standard or specification. As previously, the TMK facilities guarantee full compliance with the requirements of the API Standards and the quality of supplied products.

To provide additional confidence to our clients, in the summer of 2022 the TMK facilities have been audited by AJA Registrars CIS Ltd. and found to be in accordance with requirements API Spec. 5CT, API Spec. 5L, API Spec. 5DP & API Spec. Q1.

During a manufacturing of customer orders a third part inspection can be involved to re-assure that all material is produced in strict accordance with API Standards and customer specifications. A utilization of third part testing laboratories can be provided as well.

CONTACTS



COMMERCIAL CONTACTS

NOTES

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

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