ZAO VNIITneft
R&D Institute for OCTG Design and Operation
Private Stock Company

ENDORSED by:

A.A. Klachkov
Deputy CEO, Chief Engineer, OAO TMK
December 29, 2010

APPROVED by:

Y.N. Antipov
CEO, ZAO VNIITneft
December 14, 2010

PIPE FOR USE AS TUBING FOR WELLS

OPERATION MANUAL

DEVELOPED by:

A.A. Donskoy
CTO, ZAO VNIITneft
12/14/2010

Samara, 2010

TABLE OF CONTENTS

This Manual covers the range of tubing manufactured to GOST 633, GOST R 53366 (ISO 11960:2004), API Spec 5CT/ISO 11960 and specifications (TU) applied at the mills of Pipe Metallurgical Company (OAO TMK).

All tubing manufactured according to the referenced documents listed herein may be used for oil, natural gas and natural gas liquid (NGL) recovery, for maintaining formation pressure, as well as for oilfield water disposal, provided the recommendations given below are considered. Furthermore, the tubing may be used for well workover and servicing.

Pipe data contained herein were taken from product specifications and are provided for general reference. Detailed technical data shall be sought in applicable specifications.

This Manual covers all the occupational health and safety requirements applicable to the operation of tubing at oil/gas production facilities.

OAO TMK guarantees proper quality of pipe used in operation, provided all the requirements herein contained are complied with.

This Manual is supplied with each delivered lot of pipe and shall be binding upon the Customers.

This Manual supersedes the current version issued by ZAO VNIITneft in 2005.

1 Terms and Definitions

1.1 **Seamless steel pipe** – steel pipe made without a weld seam or any other joint, manufactured by either of forging, rolling, drawing, or extrusion.

1.2 **Defect** – imperfection of sufficient magnitude to warrant rejection of the product based on the criteria defined in product specifications.

1.3 **Power makeup** – making up a thread connection to a specified torque and/or position, using a dedicated mechanical tool or a coupling makeup machine.

1.4 **Coupling** – internally threaded cylinder for joining two lengths of threaded pipe.

1.5 **Tubing** – pipe placed in a well to recover production fluid or to inject service fluid.

1.6 **Standoff** – quantity characterizing the interference between two parts.

1.7 **Tubing lot** – specified quantity of tubing of the same heat, nominal diameter, pipe grade, wall thickness, connection type and design, covered by a single accompanying document certifying the conformity of tubing to the requirements of applicable standards/specifications.

1.8 **Heat** – metal produced by a single cycle of a melting process.

1.9 **Inspection** – process of measuring, examining, testing, gauging or otherwise comparing a unit of product with the applicable requirements.

1.10 **Thread protector** – component (*cap, ring, insert or pin*) used to protect threads and seals during storage, transportation and handling.

1.11 **Hand-tight makeup** – making up a thread connection by a single-man effort, without using a dedicated mechanical tool or a coupling makeup machine.

1.12 **Specifications** – technical document prepared according to designer's (manufacturer's) decision or at customer's request, which contains the complete set of requirements applicable to product, its manufacture and inspection.

1.13 **Electric-welded pipe** – pipe having one longitudinal seam formed by electric-resistance or electric-induction welding, without the addition of filler metal, wherein the edges to be welded are mechanically pressed together and the heat for welding is generated by the resistance to flow of electric current.

2 Pipe Specifications

2.1 Range of tubing manufactured by TMK mills is given in Table 1.

2.2 Mechanical properties of corrosion-resistant and cold-resistant tubing are given in Table 2.

Mechanical properties of tubing made to any other specifications (TU) listed in the product range are in accordance with the requirements of GOST 633.

2.3 Mechanical properties of tubing made to GOST 633 are given in Table 3.

2.4 Mechanical properties of tubing made to API Spec 5CT (ISO 11960:2004) and GOST R 53366 are given in Table 4.

Table 1 – Range of tubing manufactured by TMK mills

Standard/Specification	Pipe dimensions, mm		Pipe grade	Thread connection	Length, m
	nominal diameter	wall thickness			
GOST 633-80 Tubing and tubing couplings – Specifications	33-42	3.5	Д, К, Е	triangular, enhanced leak resistance	9.5-10.5
	48	4.0	Д, К, Е, Л		
	60	5.0	Д, К, Е, Л, М, Р		
	73	5.5; 7.0	Д, К, Е, Л, М, Р		
	89	6.5; 8.0			
	102	6.5			
	114	7.0			
GOST R 53366-2009 Petroleum and natural gas industries – Steel pipe for use as casing or tubing for wells – General specifications	33	3.38	H40, J55, L80, N80, C90, T95	triangular	Length range 1: 6.10-7.32 Length range 2: 8.53-9.75 Length range 3: 11.58-12.80
		3.50	J55, K72, L80, N80	triangular	
		4.55	H40, J55, L80, N80, C90, T95, P110	triangular	
	42.16	3.56; 4.85	H40, J55, K72, L80, N80, C90, T95	triangular	
	48.26	3.68	H40, J55, L80, N80, C90, T95	triangular	
		4.00	J55, K72, L80, N80	triangular	
		5.08	H40, J55, L80, N80, C90, T95, P110	triangular	
	60	4.24	H40, J55, L80, N80, C90, T95, Q135	triangular, trapezoidal	
		4.83; 5.00	H40, J55, L80, N80, C90, T95, P110, Q135		
		6.45	L80, N80, C90, T95, P110, Q135		
		8.53	L80, C90, T95		
	73	5.51; 7.01	H40, J55, L80, N80, C90, T95, P110, Q135	triangular, trapezoidal	
		7.82	L80, N80, C90, T95, P110	triangular	
	89	6.45; 7.34	H40, J55, L80, N80, C90, T95, P110, Q135	triangular, trapezoidal	
		8.00	J55, K72, L80, N80, C90, T95,P110, Q135		
		9.52	L80, N80, C90, T95, P110, Q135		
	102	5.74	H40, J55, L80, N80, C90, T95	triangular	
		6.50; 6.65	J55, K72, L80, N80, C90, T95, P110, Q135	triangular, trapezoidal	
	114	6.88; 7.0	H40, J55, L80, N80, C90, T95, P110, Q135	triangular, trapezoidal	
API Spec 5 CT/ ISO 11960:2004 Steel pipe for use as casing or tubing for wells	60.32	4.24	J55, L80, N80,C90	triangular, trapezoidal	Length range 1: 7.0-7.32 Length range 2: 8.53-9.75 Length range 3: 11.58-12.80
		4.83	J55, L80, N80,C90, P110		
		6.45	L80, N80,C90, P110		
	73.02	5.51	J55, L80, N80,C90, P110		
		7.01; 7.82	J55, L80, N80,C90, P110		
	88.9	5.49; 6.45	J55, L80, N80,C90, P110		
		7.34	J55, L80, N80,C90, P110		
		9.52	J55, L80, N80,C90, P110		
	101.6	5.74; 6.65; 8.38	J55, L80, N80,C90		
	114.3	6.88; 8.56	J55, L80, N80, C90		
TU 14-161-150-94 Tubing and tubing couplings, H_2S-resistant and cold-resistant	48	4.0	$Д_c$, $Е_c$, $Е_c$	triangular	9.5-10.5; up to 11 on request
	60	5.0		triangular, enhanced leak resistance	
	73	5.5; 7.0			
	89	6.5; 8.0			
	102	6.5			
	114	7.0			

Table 1 *(continued)*

Standard/Specification	Pipe dimensions, mm		Pipe grade	Thread connection	Length, m
	nominal diameter	wall thickness			
TU 14-161-173-97 Tubing and tubing couplings, cold-resistant and corrosion-resistant, for OAO Surgutneftegaz oil and gas fields	48	4.0	Кс, $Е_с$	triangular	9.5-10.5; up to 11 on request
	60	5.0		triangular, enhanced leak resistance	
	73	5.5; 7.0			
	89	6.5; 8.0			
	102	6.5			
	114	7.0			
TU 14-161-159-95 Tubing and tubing couplings of cold-resistant design	73	5.5; 7.0	Е	enhanced leak resistance	9.5-10.5; up to 11 on request
	89	6.5; 8.0			
TU 14-3-1534-87 Plain-end tubing with packing assembly made of polymeric material	60	5.0	Д, К,Е	triangular	9.5-10.5
	73	5.5; 7.0			
	89	6.5; 8.0			
TU 39-00147016-97-99 Externally upset tubing of enhanced leak resistance and couplings for them (NKMV)	60	5.0	Д, $Д_с$, К, $К_с$, Е, $Е_с$, Л, $Л_с$, М, Р	enhanced leak resistance	9.5-10.5
	73	5.5; 7.0			
	89	6.5			
TU 14-157-55-98 Galvanized seamless tubing and couplings for them	60	5.0	Д,К,Е	triangular	7.8
	73	5.5; 7.0			
	89	6.5			
	114	7.0			
TU 14-3-1718-90 Tubing with identification marking for couplings	60	5.0	К, Е, Л, М	triangular	9.5-10.5; 8.5-10.5 by agreement
	73	5.5			
TU 14-161-195-2001 Steel tubing and tubing couplings for use at gas and NGL fields	33	3.5	Д, К, Е, Л, М, Р	triangular	9.5-10.5
	42	3.5			
	48	4.0		triangular, enhanced leak resistance	
	60	5.0			
	73	5.5; 7.0			
	89	6.5; 8.0			
	102	6.5			
	114	7.0			
TU 14-161-198-2002 Tubing with extended-length external upsets and couplings for them	60	5.0	Д, К, Е, Л, М, Р До, Кс, $Е_с$, $Л_с$	triangular	9.5-10.5
	73	5.5; 7.0			
	89	6.5; 8.0			
	102	6.5			
	114	7.0			
TU 14-161-232-2008 Plain-end tubing and long-thread couplings for them	73	5.5; 7.0	Д, К, Е, Л, М, Р	triangular	9.5-10.5; up to 11 on request
	89	6.5; 7.4			
TU 1308-206-00147016-2002 Externally upset seamless tubing and H_2S- and cold-resistant couplings for them	33	3.5	$К_с$, $Е_с$, $Л_с$	triangular	9.5-10.5; up to 11 on request
	42	3.5			
	48	4.0		triangular, trapezoidal	
	60	5.0			
	73	5.5; 7.0			
	89	6.5; 8.0			
	102	6.5			
	114	7.0			

Table 2 – Mechanical properties of corrosion-resistant and corrosion-and-cold-resistant tubing

Property and unit of measurement	**TU 14–161–150–94**			**TU 14–161–159–95**	**TU 14–161–173–97**		**TU 14–161–179–99 TU 39–00147016–97–99**				**TU 14–161–198–2002**			
Pipe grade	Д$_c$	К$_c$	Е$_c$	Е	К$_c$	Е$_c$	Д$_c$	К$_c$	Е$_c$	Л$_c$	Д$_c$	К$_c$	Е$_c$	Л$_c$
UTS, σ_U, MPa (kgf/mm^2), min	510 (52.0)	647 (66.0)	657 (67.0)	689 (70.3)	647 (66.0)	657 (67.0)	509 (52.0)	647 (66.0)	657 (67.0)	755 (77.0)	517 (52.8)	647 (66.0)	655 (66.8)	723 (73.9)
YS, σ_Y, MPa (kgf/mm^2), min	402 (41.0)	519 (53.0)	549 (56.0)	552 (56.2)	519 (53.0)	549 (56.0)	380 (38.8)	519 (53.0)	549 (56.0)	647 (66.0)	379 (38.7)	490 (50.0)	552 (56.2)	655 (66.8)
max	490 (50.0)	617 (63.0)	657 (67.0)	675 (68.9)	617 (63.0)	657 (67.0)	490 (50.0)	627 (64.0)	657 (67.0)	784 (80.0)	490 (50.0)	627 (64.0)	686 (70.0)	784 (80.0)
Elongation, δ_5, %, min	20	18	16	18	18	16	20	18	16	15	20	18	16	15
HRB hardness, max	90	95	98	–	95	98	92	95	98	HRC 23	95	HRC 22	HRC 23	HRC 25
YS/UTS ratio, max	0.80	0.80	0.75	–	0.80	0.75	0.80	0.80	0.85	0.85	–	–	–	–
Notch toughness, KCV, J/cm^2 (kgf·m/cm^2), min, at:														
+ 20 °C	137 (14)	118 (12)	78 (8)	70	118 (12)	78 (8)	–	–	–	–	–	–	–	–
– 40 °C	59(6)	59(6)	59(6)	–	–	–	–	–	–	–	–	–	–	–
– 55 °C	–	–	–	40 (individual value 30)	–	–	–	–	–	–	–	–	–	–
– 60 °C	–	–	–	–	59 (6)	59 (6)	147 (15)	98 (10)	98 (10)	98 (10)	98 (10)	98 (10)	98 (10)	98 (10)
Shear fracture percentage at test temperature of – 60 °C, %, min	–	–	–	50	–	–	50	60	70	70	70	70	70	70

Table 2 *(continued)*

Property and unit of measurement	**TU 14 –161 –195 –2001**						**TU 14–1 61 –232–2008 (for tubing and tubing couplings of cold–resistant design)**					
Pipe grade	д	К	Е	Л	М	Р	Д	К	Е	Л	М	Р
UTS, σ_U, MPa (kgf/mm^2), min	655	687	689	758	823	1000	655 (66.8)	687 (66.0)	689 (70.3)	758 (77.3)	823 (83.9)	1000 (101.9)
YS, σ_Y, MPa (kgf/mm^2), min	359	491	552	654	724	930	379 (38.7)	491 (50.0)	552 (56.2)	654 (66.8)	724 (73.8)	930 (94.9)
max	552	–	758	862	921	1137	637 (65.0)	– –	758 (77.3)	862 (87.9)	921 (93.9)	1137 (116.0)
Elongation, δ_5, %, min	14.3	12.0	13.0	12.3	11.3	9.5	16	16	14	14	12	11
Reduction of area, ψ, %, min							50	50	50	50	45	45
HRB hardness, max	–	–	–	–	–	–	95	HRC22	HRC23			
YS/UTS ratio, max	–	–	–	–	–	–	–	–	–			
Notch toughness, KCV, J/cm^2 (kgf·m/cm^2), min, at:												
+ 20 °C	118	118	118	118	118	118	–	–	–	–	–	–
– 40 °C	–	–	–	–	–	–	–	–	–	–	–	–
– 55 °C	–	–	–	–	–	–	–	–	–	–	–	–
– 60 °C	98(10)	98(10)	98(10)	98(10)	98(10)	98(10)	98(10)	98(10)	98(10)	98(10)	98(10)	98(10)
Shear fracture percentage at test temperature of – 60 °C, %, min	70	70	70	70	70	70	70	70	70	70	70	70

Table 3 – Mechanical properties of tubing made to GOST 633, TU

Property description	**Normative property value for steel grade**					
	Д **Make A**	**К**	**Е**	**Л** **L**	**М**	**Р**
UTS, σ_U, MPa (kgf/mm^2), min	655 (66.8)	687 (70.0)	689 (70.3)	758 (77.3)	823 (83.9)	1000 (101,9)
YS, σ_Y, MPa (kgf/mm^2),						
min	379 (38.7)	491 (50.0)	552 (56.2)	654 (66.8)	724 (73.8)	930 (94,9)
max	552 (56.2)	– –	758 (77.3)	862 (87.9)	921 (93.9)	1137 (116,0)
Elongation, δ_5, %, min	14.3	14.0	13.0	12.3	11.3	9,5
HB Brinell hardness, max	–		255	295	305	355

Table 4 – Mechanical properties of tubing made to API Spec 5CT / ISO 11960:2004 and GOST R 53366

Group	Pipe grade	Type	Total elongation under load, %	Yield strength, MPa		Tensile strength, MPa	Hardness [a], max		Specified wall thickness, mm	Allowable hardness variation [b], HRC
				min	max		HRC	HBW		
1	H40	–	0.5	276	552	414	–	–	–	–
	J55	–	0.5	379	552	517	–	–	–	–
	K55	–	0.5	379	552	655	–	–	–	–
	K72*	–	0.5	491	–	687	–	–	–	–
	N80	1	0.5	552	758	689				–
	N80	Q	0.5	552	758	689	–	–	–	–
2	M65	–	0.5	448	586	586	22	235	–	–
	L80	1	0.5	552	655	655	23	241		
	L80	9Cr	0.5	552	655	655	23	241	–	–
	L80	13Cr	0.5	552	655	655	23	241	–	–
	C90	1 & 2	0.5	621	724	689	25.4	255	≤ 12.70	3.0
	C90	1 & 2	0.5	621	724	689	25.4	255	12.71 to 19.04	4.0
	C90	1 & 2	0.5	621	724	689	25.4	255	19.05 to 25.39	5.0
	C90	1 & 2	0.5	621	724	689	25.4	255	≥ 25.40	6.0
	C95*	–	0.5	655	758	724	–	–	–	–
	T95	1 & 2	0.5	655	758	724	25.4	255	≤ 12.70	3.0
	T95	1 & 2	0.5	655	758	724	25.4	255	12.71 to 19.04	4.0
	T95	1 & 2	0.5	655	758	724	25.4	255	19.05 to 25.39	5.0
	T95	1 & 2	0.5	655	758	724	25.4	255	≥ 25.40	6.0
3	P110	–	0.6	758	965	862	–	–	–	–
4	Q125*	all	0.65	862	1034	931	b	–	≤ 12.70	3.0
	Q125*	all	0.65	862	1034	931	b	–	12.71 to 19.04	4.0
	Q125*	all	0.65	862	1034	931	b	–	≥ 19.05	5.0
	Q135*	–	0.65	930	1137	1000	b	–	≤ 12.70	3.0
	Q135*		0.65	930	1137	1000	b	–	12.71 to 19.04	4.0
	Q135*		0.65	930	1137	1000	b	–	≥ 19.05	5.0

[a] In case of dispute, laboratory Rockwell hardness testing shall be used as a referee method.
[b] No hardness limits are specified, but the maximum variation is restricted as a manufacturing control.
* At introduction phase.

3 Marking and Packing

3.1 Marking of Pipe

3.1.1 Tubular goods shall be marked to designate customer-required data on each piece of product.

3.1.2 Marking requirements and marking information shall be in accordance with the requirements of standards/specifications for pipe.

3.2 Packing of Pipe

3.2.1 Threads, sealing shoulders and sealing bevels of pipe and couplings shall be protected from transportation and/or storage damage by special protectors made of metal, polymer or combined material (metal + polymer). Other materials may be used for protectors, provided such materials ensure that threads are protected from damage.

3.2.2 All pipe ends shall be covered by protectors which, at customer's request, may be made open or blind. In the latter case, at customer's request, dessicant (e.g. silica gel) may be placed in the interior for corrosion protection purposes.

3.2.3 The design of protectors shall ensure that the pipe and coupling threads be protected in accordance with the requirements of standards/specifications for pipe.

3.2.4 When screwing-on rings and pins, threads, shoulders and sealing bevels shall be coated with rust-preventive compound. The range and applications of compounds are given in Table 9a. At customer's request, thread-sealing compound may be used instead of rust-preventive compound.

3.2.5 Pipe shall be delivered in bundles, securely bundled at two points at least.

When bundling pipe, couplings screwed on pipe shall face the same direction. One bundle shall only contain pipe of the same pipe lot.

The bundle weight shall not exceed 5 metric tons, or, at customer's request, 3 metric tons.

3.2.6 Bundling material shall not be used as slinging fixture. The packing shall allow for multiple transfers of bundles with pipe undamaged.

3.2.7 Only pipe of the same pipe lot shall be shipped in a single carload.

Pipe of different pipe lots may be shipped in a single carload, provided the pipe of different lots are segregated, if a pipe lot or a remainder thereof is not consistent with the car capacity.

3.2.8 The following pipe packing patterns are used in TMK Company: "extra", "economic", "ordinary" and "simplified".

3.2.8.1 To fill the purchase order according to the volume (tonnage, footage) specified by the customer, one to two bundles of the ordered pipe lot, which contain less weight or less lengths of pipe than specified by packing patterns, may be formed.

3.2.8.2 For the "extra" packing pattern, tubing shall be bundled so that any contact between pipe bodies, couplings, tool joint elements, upsets be positively precluded. This is achieved by laying pipe on supports. At customer's request, supports are made as external or internal, wooden or metal/polymeric. A support provides a cradle for each length of pipe. Supports filled with pipe shall be bundled with steel band or by stud bracing.

Each bundle shall have three tags secured thereto: one tag at the aligned end of the bundle, and another two tags at the sides of the bundle.

3.2.8.3 For the "economic" packing pattern, tubing shall be bundled on external or internal wooden supports.

Threads and pipe ends shall be protected in accordance with 3.2.1 – 3.2.4.

Each bundle shall have two tags secured thereto: one tag at the aligned end of the bundle, and another tag at the left (to the aligned end) side of the bundle.

3.2.8.4 For the "ordinary" packing pattern, tubing shall be bundled on external or internal wooden supports.

Threads and pipe ends shall be protected in accordance with 3.2.1 – 3.2.4.

3.2.8.5 For the "simplified" packing pattern, tubing shall be packaged in accordance with GOST 10692 requirements and shipped according the loading patterns accepted at the manufacturer's facility.

The protection of pipe ends and threaded elements shall be in accordance with the requirements of standards/specifications applicable to the manufacture of pipe under shipment.

Plastic protectors shall be fitted on pipe ends, taking into account the geographical area of the destination, e.g., where pipe are delivered to areas with low average yearly temperature, the protectors shall be of cold-resistant design.

3.2.9 For all types of packing, when forming a bundle of tubing the couplings shall face the same direction.

3.2.10 For the "extra", "economic" and "ordinary" packing patterns, all pipe ends facing one of the opposite directions shall be coplanar. Misalignment of the opposite pipe ends in the bundle shall not exceed 0.6 m.

4 Good Practice for Pipe Operation – Requirements and Recommendations

4.1 Tubing String Forming

4.1.1 The application of tubing is determined by: scope of well (production well, injection well, pressure observation well, etc.); weight and strength properties and dimensional characteristics of tubing; well yield; downhole equipment; presence of corrosive matter in production or injection fluid.

4.1.2 Recommendations for the selection of material and standards/specifications for tubing according to the corrosive properties of fluid and the service conditions are specified in the Field Fluid Classifier (Supplement to the Operating Manual for Line Pipe, Tubing and Casing). Applications of standard tubing and SSC (sulfide stress cracking) resistant tubing are described in Table 5 and Table 6 and in the Field Fluid Classifier.

4.1.3 To prevent the occurrence of SSCC in tubing strings, the tensile stresses shall be limited by the introduction of pressure containment derating factor (K_S) for tubing operating in H_2S-bearing environment.

Table 5 – Application of standard and SSC-resistant equipment design for "oil-gas-water" multiphase fluid (gas/oil ratio < 890 nm^3/m^3)

Design	$P_{abs} < 1.83 \times 10^6$ Pa (18.6 kgf/cm^2)				$P_{abs} > 1.83 \times 10^6$ Pa (18.6 kgf/cm^2)		
	C H_2S < 4% (by volume)	4% < C H_2S < 15% (by volume)		C H_2S > 15% (by volume)	C H_2S < 0.02% (by volume)		C H_2S > 0.02% (by volume)
		P H_2S < 7.3×10^4 Pa	P H_2S > 7.3×10^4 Pa		P H_2S < 345 Pa	P H_2S > 345 Pa	
Standard	+	+	–	–	+	–	–
SSC-resistant	–	–	+	+	–	+	+

Table 6 – Application of standard and SSC-resistant equipment design for wet gas or water-cut oil (gas/oil ratio > 890 nm^3/m^3)

Design	P_{abs} < 450 kPa (4.6 kgf/cm^2)		P_{abs} > 450 kPa (4.6 kgf/cm^2)		
	C H_2S < 10% (by volume)	C H_2S < 10% (by volume)	C H_2S < 0.075% (by volume)		C H_2S > 0.075% (by volume)
			P H_2S < 345 Pa	P H_2S > 345 Pa	
Standard	+	–	+	–	–
SSC-resistant	–	+	–	+	+

String design for external pressure, internal pressure and tensile stress shall be made using the estimated safety factor n_S in H_2S-bearing environment:

$$n_S = n/K_S \quad (1)$$

where:

n_S safety factor determined in accordance with Tubing String Design Manual, for the conditions of no contact with hydrogen sulfide;

K_S pressure containment derating factor (K_S < 1.0) determined for any specific steel grade in accordance with specifications for application thereof or in accordance with other documents prepared according to standing procedures by pipe customer's specialized R&D institution, generally, with manufacturer's participation.

NOTE – Pressure containment derating factor K_S shall be determined in accordance with practices (guidelines) endorsed by the Federal Committee for Mining and Industrial Supervision (Gosgortekhnadzor) of the Russian Federation.
Tubing string compressing stress design (e.g., external gauge pressure design) shall be made at K_S = 1.0.

4.1.4 Triangular thread plain-end tubing are used in wells approximately up to 4400 m deep (depending on diameter and pipe grade), while trapezoidal thread plain-end tubing (NKM) are used in wells up to 6100 m deep.

Triangular thread upset tubing are used in wells up to 7000 m deep, while trapezoidal thread upset tubing are used in wells up to 9700 m deep.

Combining plain-end tubing and upset tubing allows to still increase the tubing string setting depth.

4.1.5 Particular feature of the connection design for round (triangular) thread tubing is that the thread is engaged at the side faces of the V-profile. Proper leak resistance of the connection is ensured by contraction of thread compound in the thread clearance space during power makeup.

NKM-type connection presents an enhanced leak resistance coupling joint with a "metal-to-metal" seal. Leak resistance of the connection is ensured by taper sealing faces located behind the thread at the side of smaller diameters. The connection provides for a contact along the internal shoulders, which sets the specified standoff when tightening the connection.

4.1.6 For coated tubing, linear mass (per 1 m of length) should be known; when forming a pipe suspension, the increase in mass shall be taken into account.

4.1.7 When it is necessary to form a combined production string containing tubing of different diameters with the difference exceeding the values specified in GOST R 23979 "Sub for Tubing – Specifications", the string shall be formed using two or more subs with one length of pipe between them. Example: for a production string containing tubing with nominal diameter of 114 mm and 60 mm, use shall be made of P114×89 sub, one length of pipe 89 mm in diameter, then P89×60 sub.

4.1.8 For combined production strings, 114 and 73 mm, 102 and 73 mm in diameter, and for strings with externally upset pipe, which are exposed to ultimate loads, to obtain the gradient stiffness transition, the running of a string to a large landing depth should be done using two subs of interim sizes instead of a single sub. Example: use P114×89 and P89×73 instead of P114×73. Similar combination applies to externally upset pipe.

4.1.9 For a production string assembled of pipe of different pipe grades, steel subs of a higher grade used shall be applied. Example: for a string containing pipe of Е and Л grades, use grade Л subs.

4.1.10 For directional wells with a rate of deviation exceeding 3° per 10 m, use couplings with special drift requirements (20° ± 5° bevel machined on the coupling outside face). When this is the case, slip-type elevator should be used.

4.1.11 For fields featuring intense deposition of wax, plaster-stone and various salts, and sand plugging, use should be made of tubing with protective coatings (enamel, epoxy, varnishes, polymers) and well servicing schedule shall be strictly observed.

4.1.12 To avoid any emergencies, a production facility should, as far as possible, use both plain-end and upset tubing of the same grade; wall thickness may be determined by a NDT method.

4.1.13 For acid formation treatment internally coated tubing should be used.

4.1.14 Tubing with regular properties should be used at ambient air temperature not below – 40°C. At air temperatures below – 40°C cold-resistant tubing should be used.

4.1.15 Tubing shall be commissioned by sets (strings). Only this approach allows to consider all the particular downhole service conditions and maximize the life of tubing.

4.1.16 The customer shall develop a form to account for the operation and turnover of the tubing pool, considering the specifics of the organizational structure.

4.2 Pipe Pre-operation Requirements

4.2.1 The scope and type of testing for tubing delivered by manufacturers shall be determined by the customer.

4.2.2 Tubing run-in-hole pre-operation activities shall be carried out at pipe yards (pipe control shops) or at dedicated sites.

4.2.3 The complete scope of tubing testing includes: marking verification for conformity to the accompanying documents; visual inspection; instrument check; nondestructive testing; internal diameter and total out-of-straightness check; hydrostatic test.

4.2.4 Each pipe lot of tubing delivered by the manufacturer shall be accompanied by a certificate of conformity to the requirements of applicable standards/specifications.

For pipe that were repaired at central pipe yards, an individual certificate indicating the field of application and well service limitations shall be issued.

In the absence of a certificate of conformity to the requirements of product standards/specifications, the acceptance, pre-operation and use of tubing for string assembly is PROHIBITED.

4.2.5 Regardless of the well and/or string application, all pipe lengths shall be subjected to visual examination.

4.2.6 The customer is free to decrease the number of controlled variables and to define the quantity of pipe subjected to inspection, taking into account the established inspection at manufacturers' facilities and the guarantees of pipe conformity to the requirements of standards/specifications (TU).

However, during transportation and delivery of pipe to the customer, some variables may be brought out of tolerance; therefore, the following shall be retained as required testing:

– visual inspection;
– hydrostatic test;
– internal diameter and total out-of-straightness check;
– failing protectors (lost in transit), gauging.

4.2.7 Instrumentation used for pipe quality control shall be certified and verified in accordance with specified procedures.

4.2.8 Internal diameter and total out-of-straightness shall be tested to make sure that tubing is fit for running the tools and equipment and to identify the out-of-straightness, local indentations and other imperfections affecting the pipe drift properties (decreasing the pipe bore). Testing shall be made using drift mandrels with outside diameters as given in Table 7 and Table 8.

Table 7 – Outside diameter of drift mandrels for tubing made to GOST 633

Dimensions in millimeters

Pipe nominal diameter	Wall thickness	Drift mandrel OD (tolerance + 0.25)	Mandrel length
33	3.5	24.0	1250
42	3.5	32.8	1250
48	4.0	37.9	1250
60	5.0	47.9	1250
73	5.5	59.6	1250
	7.0	56.6	1250
89	6.5	72.7	1250
	8.0	69.7	1250
102	6.5	85.4	1250
114	7.0	97.1	1250

4.2.9 All pipe lengths shall be subjected to hydrostatic test, to warrant the integrity of pipe body and leak-proofness of thread connection.

Duration of the hydrostatic test shall be in accordance with the requirements of applicable standards/specifications.

Table 8 – Standard drift size for tubing made to API Spec 5CT/ISO 11960

Dimensions in millimeters

Pipe outside diameter	Drift mandrel length	Drift mandrel diameter
≤ 2⅞	1067	*d* – 2.38
> 2⅞	1067	*d* – 3.18

4.3 Running and Pulling Tubing

4.3.1 Commissioned sets of new and/or used pipe shall be delivered to wells by pipe trucks; in transit, pipe and coupling threads shall be protected from damage by suitable protectors.

4.3.2 Prior to running/pulling operations, the following pre-operations shall be carried out at the well:

- make sure that during the installation of hoisting gear (rig, gin pole) the block-and-tackle arrangement is strictly aligned with the wellhead;
- prepare the workplace (walkway, supports, platforms) fully suitable for safe work;
- check tools and gears for conformity to the nameplate data;
- select and check for operability the tools and auxiliary mechanization gear kit, according to the nature of work to be performed and to the pipe sizes;
- prepare lifting subs used for running/pulling operations, which shall have been factory-manufactured or made in the well workover and servicing workshop and subjected to testing for compliance with the requirements of applicable standards/specifications.

4.3.3 The delivered set of tubing shall be stacked on supports, with couplings facing the wellhead, by sizes, according to the production string design indicated in the request/order, top to bottom, i.e. the upper string sections shall be stacked on bottom, while lower string sections, on top. At least three separators (wood boards, spacing strips) shall be laid between the tiers of pipe.

4.3.4 Prior to running the tubing equipped with suitable fixtures (packer, kickoff valve, etc.), the production string shall be drifted down to the well bottom. The drift mandrel diameter shall be specified by competent engineering functions.

4.3.5 Transfer of pipe from supports to the walkway shall be made impact-free, avoiding swinging the lifted pipe and blowing it against the parts of the hoisting arrangement, pumping unit and wellhead. When laying pipe on the walkway, the protection of pin-end thread with a ring thread protector is a requirement.

4.3.6 Prior to running in hole, the length of each length of pipe shall be measured with a measuring tape, and the resulting length shall be entered in the log. The length is defined as distance between the unengaged coupling face and the fading of pin thread run-out. The total length of pipe shall match the production string length, according to the work plan or request/order.

For pipe made to API Spec 5CT/ISO 11960, the length shall be measured from the unengaged coupling face or pipe box end to the power-tight position of coupling face along the pin end of pipe.

4.3.7 If the string contains any packers or tool extractors, the foreman shall make a dimensioned installation sketch.

4.3.8 Prior to makeup of pipe, the protective nipples shall be removed from the coupling before lifting the pipe from the walkway, while pin-end thread protectors shall be removed after the pipe is

lifted and suspended over the wellhead. Remove the storage compound and coat the clean thread with a thread-sealing compound. The compound shall be applied to the entire surface of the thread connection with a brush, wooden spatula or blade.

Thread compounds shall be only used as supplied in original container "as-delivered", labeled with the compound description, batch No and date of manufacture. Use of compound stored in a container without identification data shall be prohibited. Transfer of compound to another container shall not be allowed. Compounds shall be used as is; any thinning is unacceptable.

4.3.9 Select the type of compound in accordance with the service conditions and the requirements of applicable standards/specifications for pipe. The range of product and fields of application for thread compounds are described in 4.5.

4.3.10 A successive length of pipe, commissioned and lifted over the wellhead, shall be guided into the coupling of the preceding run-down length in vertical position; the stabbing shall be smooth and impact-free to prevent the thread from any damage. Thereafter, proceed with slow hand-tight makeup. Carry out the makeup skew-free, making sure that the pin and box threads got engaged. To prevent the threads from galling, carry on the makeup at a rate of 25 rpm, maximum; the most important makeup parameter is the makeup position of the coupling face against the thread run-out. The correct makeup position is the position where the coupling face matches the pin-end thread run-out (the last visible thread of the pin).

NOTE – In some cases, a one-thread underturn of coupling to the fading of thread run-out or a one-thread overturn of coupling beyond the fading of thread run-out is allowed.

At such makeup position the pressure gauge reading (applied makeup torque) shall be taken and recorded for statistical purposes.

This operation, with pressure gauge readings recorded, shall be performed on ten successive lengths of pipe. The average of the pressure gauge readings shall be taken as the optimum value and used to control the power assembly of thread connections. However, the crucial variable shall be the makeup position.

Durability of tubing connections under repeated running/pulling cycles is inversely proportional to the applied torque; therefore, where the leak resistance is not of a great significance, use minimum makeup torque values to extend the life of the connection.

4.3.11 Under strong wind conditions causing the block-and-tackle arrangement, together with a length of pipe lifted above the wellhead, to swing, make use of alignment fixtures; otherwise, shift to hand-tight makeup or stop the work.

4.3.12 For running/pulling operations, spider slips that will not crush the tubing should be used. Slips should be examined before using to see that they are working together.

4.3.13 Approximate makeup torque values according to GOST 633 are given in Annex A; approximate makeup torque values according to API Spec 5CT/ISO 11960 are given in Recommended Practice API RP 5C1.

For field makeup, the actual torque depends on a number of factors; therefore, to ensure proper quality of pipe assembly, the pre-selection of torque is a requirement. Failure to pre-select the optimum makeup torque for each pipe size on the field will lead to damage of threads and substantial reduction in service life (number of makeups) of thread connections.

4.3.13.1 Selection of torque for tubing with metal-to-metal sealing

To select the makeup torque for tubing with enhanced leak resistance connections of NKM type (metal-to-metal packing assembly) and NKMV type (upset ends), caliper the distance between the internal shoulder and outer face of the coupling. Then, machine a tool mark on the field end of pipe, at a distance as measured between the shoulder and outer face of the coupling. After the power makeup, the coupling face shall match the tool mark machined on the pipe pin. During power makeup, when the pipe end reaches the coupling shoulder, the torque steeply increases. Thus recorded torque will present the optimum value for the actual assembly conditions (compound type, pipe sizes, etc.).

Further makeup shall be done according to the mean torque value obtained as a result of making up ten successive lengths of pipe. The rate of power makeup for NKM, NKMV thread connections shall not exceed 10 rpm.

4.3.14 When pulling a tubing string, flaw detection allowing to quickly separate heavily worn lengths of pipe which are subject to removal, shall be performed.

4.3.15 Breakout tubing tongs shall be placed close to the coupling, but not immediately adjacent, to prevent the tong dies from crushing the pipe surface. Tapping at the coupling with a hammer to loosen the connection is not recommended. However, if necessary, it is allowed to slightly tap at the mid-length of the coupling circumferentially, with a flat face of the hammer.

4.3.16 To prevent the thread from injurious damage, first proceed with the breakout using 3- to 5-revolution power tongs; then shift to manual breakout. On completion of breakout, the pipe length shall be smoothly removed from the coupling; no jerking shall be allowed when pulling a pipe length off the coupling.

Exercise particular care to watch that the thread be completely disengaged before pulling the pipe off the coupling.

4.3.17 If pipe are positioned vertically at the rig, they shall be placed on a robust wooden platform, without pin-end thread protector.

4.3.18 To prevent corrosion, all thread connections shall be cleaned and greased. Prior to laying pipe on the walkway, the threads shall be covered with thread protectors.

4.3.19 Tubing placed at the rig in vertical position shall be sufficiently supported to prevent them from bending.

4.3.20 Before leaving the storage area, fasten the pipe racked on the setback securely.

4.3.21 Prior to re-running, make sure that the pipe threads are free from injurious damages and are prepared in accordance with 4.3.8.

4.3.22 To provide for the uniform wear of thread connections and tubing body, pipe lengths of the same grade should be interchanged between the upper and the lower portion of the tubing string.

4.3.23 To prevent the string from leakage, all connections should be re-tightened on a regular basis.

4.3.24 In the event of pipe sticking, use a calibrated load indicator. In doing this, take into account the string tensioning and do not consider it freeing of stuck string.

4.3.25 After applying a substantial force to free the tubing string from sticking, the torqueing of all thread connections should be done.

4.3.26 Prior to laying pipe for storage or to recurring to operation, pipe and thread connections shall be tested, defective pipe shall be marked as such for subsequent repair and testing.

4.3.27 When pulling tubing due to damage, the tubing shall be examined to preclude similar damages in the future. A damaged pipe length should be pulled "as failed".

4.4 Equipment Requirements for Conducting Running/Pulling

4.4.1 For running the tubing, the bearing surface of the elevator shall be flat and the internal diameter shall be drifted to ensure that tubing properly fits the elevator.

4.4.2 Watch carefully that no compound makes its way to working (notch ragged) surfaces of slips contacting the tubing.

Immediately remove the compound in case of any ingress.

4.4.3 The operation of elevator spider with worn, distorted or damaged parts shall be prohibited.

4.4.4 Dimensions of dies and slips shall be consistent with the diameter of pulled/run pipe.

4.4.5 To obtain the required makeup torque, use tubing tongs equipped with a pressure-gauge torque indicator. The tongs size shall be consistent with the pipe size. The tongs shall be properly set against a pipe and the dies shall be perfectly fit to prevent the pipe from crushing and to minimize grooves and dents on the metal surface.

4.5 Thread Compound Selecting Recommendations

4.5.1 For making up connections use compounds listed in standards/specifications, as the compound greatly affects the leak resistance of threads. Thread compounds shall take up high specific pressures, resist high temperatures, seal voids between the mating threads, be easy in application, remain on threaded surfaces for a long time, etc.

4.5.2 The requirements applicable to service performance of thread compounds for tubing include the following:

- compatible frictional properties allowing for correct and even makeup;
- adequate lubricating properties allowing to facilitate joint makeup and breakup without galling or damaging mating surfaces of the joint;
- adequate sealing properties for thread connections that will not impair the properties of non-thread connections, i.e., "metal-to-metal" connections, according to service requirements;
- physical and chemical stability, both in service and in storage;
- properties allowing for effective use of the compound on joint mating surfaces under anticipated service conditions and in the anticipated environment.

4.5.3 When evaluating the suitability of thread compound, the customer shall define the conditions, in which the compound will be used and, in addition to the laboratory test data according to compound specifications, take into account field test results and field service experience.

4.5.4 Recommended compounds and their respective fields of application are given in Table 9.

4.5.5 The minimum quantity of compound shall be spread between pin and box in a proportion of ⅔ (box) to ⅓ (pin). In exceptional cases, where compound is to be only applied on one joint member, it should preferably be the box. The average compound consumption for making up thread connections in the field is given in Table 10.

4.5.6 Compound of the same type shall be present at a workplace; such compound shall be manufactured to the same specifications (TU), supplied in original container "as delivered", labeled with the compound description, batch No and date of manufacture. The compound to be applied shall be homogenous, of grease consistence, free from solid inclusions (rocks, sand, dried mud, chips, etc.).

4.5.7 Service containers with compound shall be covered to prevent the compound from contamination and ingress of foreign material.

Table 9 – Thread compound fields of application

Compound	Application
VALMA-API Norm TU 0254-010-54044229-2009	Making up and sealing thread connections of drill pipe, casing and tubing, including those of cold-resistant and H_2S-resistant design. Temperature range: – 50°C to + 200°C. Complies with requirements of ISO13678 and API RP 5A3.
RUSMA-1 TU 0254-001-46977243-2002	Sealing of round and trapezoidal threads for connections of casing, tubing, drill pipe and line pipe of any diameter under high-pressure service conditions. Complies with requirements of ISO13678 and API RP 5A3.
RUSMA R-4 TU 0254-031-46977243-2004	Sealing and making up thread connections of drill pipe, casing and tubing. Complies with requirements of ISO13678 and API RP 5A3.
RUSMA R-5 TU 0254-028-46977243-2004	Inhibited thread compound intended for sealing and corrosion protection of thread connections for casing and tubing of downhole and field equipment operated at NGL fields containing hydrogen sulfide (H_2S) and carbon dioxide (CO_2). Complies with requirements of ISO13678 and API RP 5A3.
RUS-OLYMP TU 0254-009-54044229-05	Tool joints for drill pipe of foreign and home manufacture; also, for making up and sealing thread connections of casing and tubing. Temperature range: – 50°C to + 200°C. Complies with requirements of ISO 13678.
RUS-PREMIUM TU 0254-008-54044229-05	Making up thread connections of casing and tubing with metal-to-metal sealing, including gas-tight connections of VAM type and VAGT, SECFR, SPMS2 connections for sour service, harmonized with the former. Can also be used as storage compound. Complies with requirements of ISO 13678 and API RP 5A3.
RUS, RUS-1 TU 0254-005-54044229-02	Making up and sealing thread connections of casing, tubing and line pipe. Temperature range: – 30°C to + 200°C.
RUS-SNOW QUEEN TU 0254-006-54044229-02	Making up and sealing thread connections of drill pipe, casing and tubing, including those of cold-resistant and H_2S-resistant design. Temperature range: – 60°C to + 200°C.
Bestolife API Modified Bestolife	Making up casing, tubing, and line pipe. Prevents surface from abrasion during feeding; water absorption resistant; prevents leakage; resistant to segregation and volume changes; neither solidifies, nor dries, vaporizes or oxidizes. Contains rust prevention agents and H_2S inhibitors which ensures pitting resistance. Complies with or exceeds specifications given in API RP 5A3.
Bestolife 270^R Besto-life	Drill collars, casing strings, tubing, pipeline joints and connections. Ensures maximum protection and sound sealing for all thread connections (other than oxygen lines). Proprietary formula includes > 60% of metallic lead plus dedicated nonmetallic additions which are applicable in any conditions and resistant to H_2S and drilling mud.
2000 NM Bestolife	Long-term storage compound. Main solid components are chemical-resistant, remain stable at ≥ 1000°F and anti-corrosive. Complies with or exceeds performance indicators specified in API RP 5A3 and requirements of API Spec 5CT.

4.5.8 Prior to application compound shall be thoroughly stirred. Avoid any contact of compound with skin or its ingress in gastrointestinal tract.

4.5.8 The customer shall be responsible for compliance with the environmental requirements within the area of work and for proper selection, use and disposal of thread compound.

Table 9a – Storage compound fields of application

Compound	Application
IP-1 (L) and (3) TU 33.1 01 820-80	Hydrocarbon cylinder oil, thickened with a lime soap of acids extracted from cottonseed oil and hydrogenated fat; contains extreme-pressure additive. Features high water resistance and extreme-pressure properties, low freezing resistance and mechanical stability, adequate oil separation properties. Usable at 0° to + 70°C (L); at – 10° to + 70°C (3).
Rust Veto AS HOUGHTON	Rust preventive compound of grease type containing high-quality corrosion-preventive agents; intended for use under most severe climatic conditions. Specially developed for long-term protection of threads on tubulars exposed to corrosive environment. The compound ensures up to 12month corrosion protection during outdoor storage in corrosive environment.
KENDEX-OCTG rust-preventive compound	Specially developed for long-term storage of OCTG; resistant to sulfurous reducers and various bacteria which, under normal conditions, contribute to corrosion.

Table 10 – Average thread compound consumption for making up thread connections under field conditions

Pipe outside diameter, mm	Consumption of compound per joint, g
60	13
73	16
89	27
102	32
114	37
NOTE – Consumption varies for different types of thread connection and compound.	

4.5.10 Use of machinery oil, diesel oil as substitutes for greases, as well as dry makeup shall be PROHIBITED.

4.6 Basic Recommendations for Prevention of Emergencies

4.6.1 Causes for tubing damage

4.6.1.1 Types of and causes for tubing damage:

- incorrect selection of pipe grade for tubing;
- careless handling and transportation;
- thread damage due to loosening or dropping of thread protector (ring, nipple);
- insufficient storage protection;
- use of worn or improper equipment for handling, improper grips for pipe tongs or pincers;
- noncompliance with rules for tubing running and pulling;
- worn couplings (worn outer surface, thread);
- replacement of worn couplings with those made not to requirements of applicable standards/specifications;
- string dropping, even a short distance.

4.6.1.2 Leakage of joints may be caused by the following:

- unsuitable thread compound and/or improper application thereof;
- greasy/dirty thread (traces of rust-preventive compound, corrosion, contamination);
- insufficient or excessive thread tightening;
- distorted thread due to inaccurate fit when stabbing pin to box (blow, skew when stabbing, etc.);
- frequently repeated running/pulling operations.

4.6.2 Recommendations for prevention of emergencies

4.6.2.1 Before proceeding to operation of wells, a degree of risks of emergency failure for tubing strings shall be reviewed. In particular, such risks may be caused by severe service conditions (low temperatures, corrosive environment, etc.). If required, mitigation arrangements shall be developed.

4.6.2.2 To reduce the emergencies during operation of wells:

- strictly comply with the requirements of current procedural regulations and safety codes applicable to petroleum and natural gas industry;
- monitor the condition of well and serviceability of equipment and tools;
- know and observe operating procedures for pipe and equipment;
- monitor applied loads;
- make up connections with tongs equipped with a torque indicator;
- implement, in full and in timely manner, arrangements for fault-free working at the well;
- loads applied to tubing in operation shall not exceed the limit loads according to Annex A, specification (TU) requirements, recommendations given in "Thread Connections Technical Catalog" (TMK publication), and ISO 10405, for pipe made to API Spec 5CT/ISO 11960, with safety factors applied.

To avoid emergencies, running of tubing shall be prohibited:

- if the factory marking data are inconsistent with the values stated in the certificate;
- if the inspection results in detection of defects of magnitude which is greater than allowable;
- in case of improper seating of coupling at the mill (standoff not in conformity with specification requirements, explicit misalignment between pipe and coupling, etc.);
- when the pipe wall thickness including the wall thickness at the threaded end in the face-end plane, is not in compliance with the specification requirements;
- if hydrostatic testing reveals pipe or thread connection leakage.

4.6.2.3 Generally, fields put on production shall be considered potentially corrosive; at early phases of development, surveys for most corrosive areas shall be undertaken, to avoid corrosion-induced failures. Such surveys shall include:

- determination of corrosive gases (carbon dioxide and hydrogen sulfide) in the production fluid. Also, determination of reservoir water pH and chemistry (iron ions, organic acids, total chlorides and other corrosive components) is also recommended;
- corrosion rate testing on test specimens taken from the same materials that were used for manufacture of pipe in operation;
- inspection/monitoring using measurement equipment or optical instrumentation.

4.6.2.4 For pipe surface, the most common corrosion failures are: pitting, stress-corrosion cracking, sulfide stress cracking, box wear. Other potential types of local corrosion failure include erosive

wear, spot pitting. The depth of pitting and spot pits may be measured using a suitable measuring instrument (depth gauge or profile meter). To detect cracking, other aids may be necessary, e.g. magnetic-particle examination. Generally, corrosion failure occurs due to exposure of metal surface to reservoir water; corrosion failure may be aggravated by abrasive effects of pumping equipment, gas lift, or high recovery rates. The development of corrosion is also affected by non-uniformity of metal microstructure, surface condition, morphology and adhesion of depositions (corrosion products may or may not adhere to the pipe walls, which results in the formation of galvanic pairs). Corrosion can also be influenced by dissimilar metals in close proximity to each other (bimetallic corrosion). Since corrosion may result from many causes and influences and take different forms, no simple or universal remedy can be given for control. Each problem shall be treated individually, and the solution shall be attempted in light of known factors and specific operating conditions.

For wells where internal or external tubing corrosion is known to exist and corrosive fluids are being produced, the following measures can be employed:

a) In flowing wells, the annulus can be packed off and the corrosive fluid confined to the inside of the tubing. The inside of tubing can be protected with special liners, coatings, or inhibitors.

b) In pumping and gas-lift wells, inhibitors introduced via the casing-tubing annulus afford appreciable protection. In this type of completion, especially in pumping wells, better operating practices can also aid in extending the life of tubing, such as through the use of rod protectors, rotation of tubing, and longer and slower pumping strokes.

4.6.2.5 For new pipe made to GOST 633, recommended performance properties are listed in Annex A, while for pipe made to API Spec 5CT/ISO 11960, in ISO/TR 10400:2007(E).

4.6.3 Investigation of industrial accidents should be conducted in accordance with "Guidelines for investigation of industrial accidents with drill pipe, casing and tubing, and for claim documenting".

4.7 Reconditioning

4.7.1 Organization of timely and high-quality reconditioning of used tubing is an important factor contributing to reducing pipe consumption and preventing tubing strings from failure.

Reconditioning shall be performed using suitable equipment intended for tubing diagnostics and repair.

4.7.2 Currently, the recognized pipe body testing methods are: visual inspection, measurement, electromagnetic examination, ultrasonic testing, eddy-current examination, etc. The operation of pipe leads to the occurrence of the following commonly encountered defects: inside and outside corrosive damages; longitudinal injuries of inside surface by ropes; axial and circumferential outside marks caused by dies and tubing tongs; undercuts; transverse cracking and wear of tubing inside surface caused by sucker rods.

4.7.3 Wall thickness may be measured by micro gauges, ultrasonic and X-ray instruments having an accuracy at least 2%, calibrated to reference standards with wall thickness close to that of pipe.

4.7.4 Used pipe shall be categorized according to the decrease in wall thickness as specified in Table 11. The percentages are the decrease in wall thickness against the nominal wall thickness. The wall thickness is thinned both from the outside and the inside of the pipe body. The following pipe section shall not be categorized in accordance with Table 11: threaded and/or upset pipe ends.

Depending on service conditions, the thinning of wall thickness at upset ends having a wall thickness greater that that of the pipe body is allowed down to the values exceeding those specified, provided this does not impair the pipe quality. Damage and/or thinning of wall thickness at threaded ends requires individual evaluation, depending on service conditions.

Table 11 – Used tubing categorization

Category	Decrease in wall thickness, % of nominal value	Residual wall thickness, min, %
2	0 – 15	85
3	16 – 30	70
4	31 – 50	50
5	> 50	< 50

4.7.5 If the pipe surface contains cracks detectable through visual, optical or magnetic-particle inspection, such pipe shall be rejected and disqualified for further operation.

4.7.6 The use of used tubing will depend on the metal loss type. Pitted pipe may not be used in certain corrosive environments, however, may be quite satisfactorily operated in a corrosion-free environment. Pipe that suffered substantial, however even, metal loss caused by mechanical wear are less sensitive to corrosion attack, but will require re-calculation of performance properties according to the minimum residual wall thickness.

4.7.7 After makeup, the dimensional characteristics of thread connections will change; therefore, these will differ from those specified.

4.7.8 The final evaluation of pipe for fitness for further operation shall require the pipe inside surface condition testing and residual wall thickness gauging to determine the pipe body collapse resistance, burst strength and tensile strength, thread condition (leak resistance), pin end outside diameter (to evaluate makeup feasibility).

Depending on circumstances and existing risks, in addition to usual wall thickness gauging, thread gauging may be required to determine the final performance properties.

4.7.9 Often, tubular products damaged in operation or due to improper handling, may be repaired. The repair shall only be performed in accordance with specification requirements. Operability of reconditioned thread connections shall necessarily be confirmed by measurements and testing in accordance with the requirements of applicable standards and other specifications.

5 Transportation and Storage

5.1 Transportation

5.1.1 Transportation of pipe shall be carried out by rail (on open-top fright cars), by truck or by water in accordance with Shipping Rules and Specifications for Cargo Loading and Fastening applicable to the specific means of transportation.

5.1.2 Stringers shall be provided across the car or truck body bottom. Pipe bundles shall be provided with transportation straps.

5.1.3 When carrying pipe on flat wagon, upright posts, wire-tied above the pipe, shall be installed on the car sides.

5.1.4 For truck transportation, the following precautions shall be taken:

– load pipe on bolsters and tie down with suitable chain at the bolsters;
– load pipe with all couplings on the same end of the truck.

5.1.5 Bundling material shall not be used as slinging fixture. The packing shall allow for multiple transfers of bundles with pipe undamaged.

5.1.6 When using pipe trucks, care shall be taken to avoid the pipe flexure. During transportation the pipe ends shall not protrude by more than 1 m beyond the vehicle dimensions.

5.1.7 Hitting pipe or bundles against each other or against any metal parts of the vehicle is unacceptable.

5.1.8 Dragging pipe or dropping pipe on the ground shall be STRICTLY PROHIBITED.

5.1.9 Before unloading make sure that the thread protectors are tightly in place.

5.1.10 When loading, unloading and stacking the pipe, use hoisting machinery or safe skids. Do not unload pipe by dropping. For long pipe, use of end-looped braces is recommended. When unloading by hand, use rope slings. When rolling down skids, roll pipe parallel to the stack and do not allow pipe to gather momentum or to strike the ends, because even with thread protectors in place there is danger of damaging the threads.

5.1.11 Special handling may be required for sour service and CRA material. Impact against adjacent pipe or other objects may cause a local increase in the hardness of the pipe to the extent that they become susceptible to sulfide stress cracking.

5.2 Storage

5.2.1 All tubing shall rest on supports.

5.2.2 The following categories of pipe shall be stored on individual supports:

a) new pipe received from manufacturers;
b) pipe sorted out by type of reconditioning;
c) reconditioned pipe;
d) rejected pipe not subject to repair;
e) pipe grouped in sets for forming strings and prepared for delivery to the facility.

5.2.3 Each support shall accommodate the pipe of the same characteristics: type, nominal diameter, wall thickness, grade.

5.2.4 The following requirements apply to the supports and the pipe laying:

a) the support bearing surface shall be horizontal to avoid any inadvertent rolling of pipe; the support design shall ensure that the pipe rest on the support at least at three points of contact, to avoid any inadvertent rolling down; each support shall be provided with upright posts;

b) the support bearing surface should be no less than 500 mm above the ground;

c) pipe should not be stacked higher than 3000 mm;

d) provide wooden strips as separators between successive layers of pipe so that the couplings do not contact each other. Use at least three spacing strips.

The strips between layers of pipe shall be coplanar.

5.2.5 Each support shall be provided with a nameplate containing the specifications of accommodated pipe.

5.2.6 Threads shall be coated by rust-preventive compound and covered with thread protectors. Compound product range and field of application are given in Table 9a.

Thread surface and outside surface of pipe in storage shall be inspected periodically and protective coatings re-applied when necessary. Re-application schedule shall be in accordance with GOST 9.014.

5.2.7 Storage of acids, alkalis and other corrosive chemicals close to the supports shall be forbidden.

6 Safety Requirements

To ensure safe operation of pipe, make sure that the requirements of the manufacturer's Operation Manual for the delivered product and other Manufacturer's recommendations, as well as combined corporate regulations for operation of pipe, duly approved at drilling facilities and consistent with the Manufacturer's Operation Manual and PB 08-624-03 "Petroleum and Natural Gas Industry Safety Code" are positively complied with.

7 Manufacturer's Guarantee

The Manufacturer warrants that the pipe and couplings are and remain in conformity to specification requirements within the period specified in the contract (purchase order), provided the pipe operation and storage procedures be complied with.

Annex A
(normative)
Strength Properties and Makeup Torque Values for Tubing Made to GOST 633

Table A.1 – Internal and external (collapsing) pressure creating stresses in pipe body equivalent to yield strength, for pipe made to GOST 633 (MPa)

Nominal diameter, mm	Wall thickness, mm	Internal pressure P_{int} for pipe grades						External pressure P_{ext} for pipe grades					
		Д		К	Е	Л	М	Д		К	Е	Л	М
		Make A	Make B					Make A	Make B				
33	3.5	80.9	79.4	91.0	102.5	121.4	134.5	56.1	55.1	66.5	72.6	84.8	96.7
42	3.5	64.0	62.9	71.5	80.5	95.3	105.5	41.0	40.3	50.7	55.2	63.8	72.0
48	4.0	64.0	62.8	71.5	80.5	95.3	105.5	42.6	41.8	52.7	57.5	66.5	75.1
60	5.0	64.0	62.8	71.5	80.5	95.3	105.5	40.3	39.6	50.0	54.6	63.1	71.4
73	5.5	50.1	49.2	64.8	72.8	86.2	95.6	37.5	36.8	46.5	50.5	58.0	65.2
	7.0	63.7	62.6	82.4	92.7	109.8	121.6	52.9	51.9	66.0	72.3	84.1	95.8
89	6.5	48.5	47.6	62.7	70.5	83.5	92.6	37.9	37.2	46.5	50.6	58.0	65.0
	8.0	59.6	58.5	77.0	86.6	102.6	113.6	50.4	49.5	63.1	69.0	80.4	91.0
102	6.5	42.4	41.6	54.8	61.7	73.0	81.0	30.7	30.1	37.6	40.5	45.9	50.8
114	7.0	40.8	40.0	52.5	59.0	70.0	77.8	30.0	29.4	36.2	38.8	43.9	48.3

Table A.2 – Ultimate joint load and ultimate tension load for tubing made to GOST 633 and TU

Nominal diameter, mm	Wall thickness, mm	Ultimate joint load Q_u for plain-end pipe with triangular thread, kN						Ultimate joint load Q_u for upset pipe with triangular thread, kN						Ultimate tension load for enhanced leak resistance pipe with trapezoidal thread, kN						Ultimate tension load for enhanced leak resistance upset pipe (NKMV) and extended-length end pipe (NKMVU) with trapezoidal thread, kN				
		Д		К	Е	Л	М	Д		К	Е	Л	М	Д		К	Е	Л	М	Д	К	Е	Л	М
		Make A	Make B					Make A	Make B					Make A	Make B									
33	3.5	63	62	82	92	-	-	124	122	162	177	219	242	-	-	-	-	-	-	-	-	-	-	-
42	3.5	81	80	105	118	-	-	160	157	208	229	272	312	-	-	-	-	-	-	-	-	-	-	-
48	4.0	115	113	148	160	192	222	214	210	273	310	356	410	-	-	-	-	-	-	-	-	-	-	-
60	5.0	199	196	250	285	337	388	328	322	425	468	552	640	269	265	348	382	452	522	322	425	468	552	640
73	5.5	282	278	365	402	476	540	443	435	572	620	746	855	369	363	476	524	610	716	-	-	-	-	-
73	7.0	376	370	486	535	636	730	550	540	712	783	935	1065	475	468	617	680	804	925	435	572	620	743	855
89	6.5	421	415	546	620	710	820	633	622	818	900	1065	1227	558	549	710	780	921	1064	540	712	783	935	1065
89	8.0	-	-	-	-	-	-	768	754	995	1090	1298	1435	681	670	882	967	1142	1320	622	818	900	1065	1227
102	6.5	447	440	580	640	755	870	736	723	951	1040	1237	1430	632	622	820	902	1065	1230	754	995	1090	1298	1435
114	7.0	554	545	717	833	932	1076	896	880	1155	1270	1505	1745	778	766	1070	1110	1310	1510	-	-	-	-	-

Table A.3 – Recommended makeup torque for tubing made to GOST 633 and TU

Nominal diameter, mm	Wall thickness, mm	Makeup torque for plain-end pipe with triangular thread, Nm					Makeup torque for upset pipe with triangular thread, Nm					Makeup torque for enhanced leak resistance pipe with trapezoidal thread, Nm					Makeup torque for enhanced leak resistance upset pipe (NKMV) and extended-length end pipe (NKMVU) with trapezoidal thread, Nm				
		Д	К	Е	Л	М	Д	К	Е	Л	М	Д	К	Е	Л	М	Д	К	Е	Л	М
		360	400	440	-	-	770	920	1090	-	-	-	-	-	-	-	-	-	-	-	-
42	3.5	460	514	570	-	-	940	1120	1330	-	-	-	-	-	-	-	-	-	-	-	-
48	4.0	485	545	685	-	-	1090	1300	1550	1745	1930	-	-	-	-	-	-	-	-	-	-
60	5.0	880	1010	1185	1400	1495	1605	1910	2255	2565	2840	1455	1925	2165	2600	2875	2840	3680	4130	4900	5420
73	5.5	1305	1555	1835	2090	2290	2050	2440	2890	3285	3635	2130	2760	3105	3680	4070	3345	4325	4875	5775	6395
73	7.0	1700	1980	2280	2520	2780	2680	3105	3575	3955	4370	2445	3165	3560	4215	4665	3925	5085	5720	6775	7505
89	6.5	1840	2180	2595	2945	3220	2840	3375	4005	4770	5045	2840	3680	4140	4905	5425	4390	5690	6395	7580	8390
89	8.0	-	-	-	-	-	3255	3965	4595	4975	5500	3835	4970	5585	6620	7325	-	-	-	-	-
102	6.5	2215	2975	3160	3600	4395	3185	3785	4510	5180	5730	3365	3785	4900	5805	6425	-	-	-	-	-
114	7.0	2465	3355	3545	4005	4945	3565	4240	4990	5745	6360	3695	4785	5380	6375	7060	-	-	-	-	-

NOTE 1 – Under normal conditions, ±25% variation of torque from tabulated values is considered to be within tolerance.
NOTE 2 – Making up should be based on the position of mating parts, rather than on the torque value. Refer to 4.3.13.

Annex B
(informative)
List of Referenced Documents

1 GOST 9.014-78 ESZKS. Temporary corrosion protection. General requirements

2 GOST 633-80 Tubing pipes and couplings for them. Specifications

3 GOST R 23979-80 Sub for tubing. Specifications

4 GOST R 51906-2002 Thread connections for casing, tubing and pipelines and thread gauges for them. General technical requirements

5 GOST R 53365-2009 Pipe for use as casing and tubing and couplings for them. Basic parameters and inspection of thread connections. General technical requirements

6 API Specification 5CT (8^{th} Edition). Specification for casing and tubing / ISO 11960:2004 Petroleum and natural gas industry – Steel pipe for use as casing and tubing for wells

7 API Specification 5B (15^{th} Edition, 2008). Threading, gauging and thread inspection of casing, tubing and line pipe threads, Petroleum and natural gas industry – Steel pipe

8 API RP 5C1 Recommended Practice for care and use of casing and tubing – 18^{th} Edition, 1999

9 API RP 5A3, 2^{nd} Edition, 2003. Recommended Practice on thread compounds for casing, tubing, line pipe

10 ISO/TR 10400:2007(E) Petroleum and natural gas industry – Equations and calculations for the properties of casing, tubing, drill pipe and line pipe used as casing or tubing

11 ISO 10422:1993 Petroleum and natural gas industry – Threading, gauging and thread inspection of casing, tubing and line pipe threads

12 ISO 11960:2004 Steel pipe for use as casing or tubing for wells

13 TU 14-161-150-94 Tubing and tubing couplings, H_2S-resistant and cold-resistant

14 TU 14-161-173-97 Tubing and tubing couplings, cold-resistant and corrosion-resistant, for OAO Surgutneftegaz oil and gas fields

15 TU 14-161-159-95 Tubing and tubing couplings of cold-resistant design

16 TU 14-3-1534-87 Plain-end tubing with packing assembly made of polymeric material

17 TU 39-00147016-97-99 Externally upset tubing of enhanced leak resistance and couplings for them (NKMV)

18 TU 14-157-55-98 Galvanized seamless tubing and couplings for them

19 TU 14-161-195-2001 Steel tubing and tubing couplings for use at gas and NGL fields

20 TU 14-3-1718-90 Tubing with identification marking for couplings

21 TU 14-161-198-2002 Tubing with extended-length external upsets and couplings for them

22 TU 14-161-232-2008 Plain-end tubing and long-thread couplings for them

23 TU 1308-206-00147016-2002 Externally upset seamless tubing and H_2S- and cold-resistant couplings for them

24 TU 0254-010-54044229-2009 Thread compound VALMA-API Norm

25 TU 0254-001-46977243-2002 Thread compound RUSMA-1

26 TU 0254-031-46977243-2004 Thread compound RUSMA R-4

27 TU 0254-028-46977243-2004 Inhibited thread compound RUSMA R-5

28 TU 0254-009-54044229-05 Thread compound RUS-OLYMP

29 TU 0254-008-54044229-05 Thread compound RUS-PREMIUM

30 TU 0254-005-54044229-02 Sealing thread compound RUS, RUS-1

31 TU 0254-009-54044229-05 Sealing thread compound RUS-Snow Queen

32 TU 33.101820-80 Compound IP-1 (L) and (3).

33 Guidelines for investigation of industrial accidents with drill pipe, casing and tubing, and for claim documenting. Association of drill contractors. Moscow, 1997

34 RD 08-624-03 Petroleum and Natural Gas Industry Safety Code

Certified the foregoing Document to be a true, complete, and accurate English translation of the original document translated from Russian by the INTERSERVICE translation agency.

A.Itskovich
Director