
**Steel forgings and rolled or forged bars for
pressure purposes — Technical delivery
conditions —**

Part 3:

Nickel steels with specified low temperature
properties

*Pièces forgées et barres laminées ou forgées en acier pour appareils
à pression — Conditions techniques de livraison —*

*Partie 3: Aciers alliés au nickel avec caractéristiques spécifiées à basse
température*



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9327-3 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 10, *Steel for pressure purposes*.

This first edition, together with parts 1, 2, 4 and 5 of ISO 9327, cancels and replaces ISO 2604-1:1975.

ISO 9327 consists of the following parts, under the general title *Steel forgings and rolled or forged bars for pressure purposes — Technical delivery conditions*:

- *Part 1: General requirements*
- *Part 2: Non-alloy and alloy (Mo, Cr and CrMo) steels with specified elevated temperature properties*
- *Part 3: Nickel steels with specified low temperature properties*
- *Part 4: Weldable fine grain steels with high proof strength*
- *Part 5: Stainless steels*

Steel forgings and rolled or forged bars for pressure purposes — Technical delivery conditions —

Part 3:

Nickel steels with specified low temperature properties

1 Scope

1.1 This part of ISO 9327 applies to forgings and rolled or forged bars in thicknesses up to 50 mm manufactured from the steels listed in Table 1 and to be delivered according to the specifications given in ISO 9327-1.

1.1 This part of ISO 9327 covers the following data:

- a) in Table 1 the limits for
 - the chemical composition according to the cast analysis;
 - the tensile properties at room temperature;
 - the indications on the usual heat treatment condition at the time of delivery;
- b) in Table 2 the permissible product analysis tolerances on the limiting values given for the cast analysis;
- c) in Table 3 the minimum impact energy values.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 9327. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 9327 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 148:1983, *Steel — Charpy impact test (V-notch)*.

ISO/TR 4949:1989, *Steel names based on letter symbols*.

ISO 9327-1, *Steel forgings and rolled or forged bars for pressure purposes — Technical delivery conditions — Part 1: General requirements*.

ISO/TR 15461:1997, *Steel forgings — Testing frequency, sampling conditions and test methods for mechanical tests*.

3 Terms and definitions

For the purposes of this part of ISO 9327, the terms and definitions given in ISO 9327-1 apply.

4 Ordering and designation

See ISO 9327-1.

5 Requirements

See ISO 9327-1 and Tables 1 to 3.

6 Inspection, testing and conformity of products

See ISO 9327-1.

7 Marking

See ISO 9327-1.

Table 1 — Chemical composition (cast analysis), room temperature mechanical properties and heat treatment conditions of Ni-alloyed steels with specified low temperature properties

Line No.	Steel type		Chemical composition % by mass ^b								Mechanical properties at room temperature ^c				Heat treatment							
	"new"	"old" designation ^a in accordance with ISO/TR 4949 ISO 2604-1	C max.	Si max.	Mn max.	P max.	S max.	Al _{total} min.	Ni	Others	Thickness of the ruling section ^d t _R	R _e	R _m	A min. DIR:		Symbol ^e	Usual reference heat treatment conditions					
											mm	N/mm ² min.	N/mm ²	x	y			Austenitizing or solution temperature °C	Cooling in t	Tempering °C	Cooling in t	
1	11MnNi5-3	—	0,14	0,50	0,70 to 1,50	0,025	0,020	0,020	0,30 to 0,80	Nb ≤ 0,05 V ≤ 0,05	≤ 30 30 < t _R ≤ 50	285 275	420 to 530	24	24	N (+T)	880 to 940	a	580 to 640	a		
2	13MnNi6-3	—	0,16	0,50	0,85 to 1,65	0,025	0,020	0,020	0,30 to 0,85	Nb ≤ 0,05 V ≤ 0,05	≤ 30 30 < t _R ≤ 50	355 345	490 to 610	22	22	N (+T)	880 to 940	a	580 to 640	a		
3	15NiMn6	---	0,18	0,35	0,80 to 1,50	0,025	0,020	—	1,30 to 1,70	V ≤ 0,05	≤ 30 30 < t _R ≤ 50	355 345	490 to 640	22	22	N	850 to 900	a	600 to 660	a, w		
																N+T					600 to 660	a, w
																Q+T					600 to 660	a, w
4	12Ni14G1	F44	0,15	0,35	0,30 to 0,80	0,025	0,020	—	3,25 to 3,75	V ≤ 0,05	≤ 30 30 < t _R ≤ 50	285 275	450 to 600	23	23	N	830 to 880	a	580 to 640	a, w		
																N+T					580 to 640	a, w
																Q+T					830 to 870	w, o
5	12Ni14G2	—	0,15	0,35	0,30 to 0,80	0,025	0,020	—	3,25 to 3,75	V ≤ 0,05	≤ 30 30 < t _R ≤ 50	355 345	470 to 620	22	22	N	830 to 880	a	580 to 640	a, w		
																N+T					580 to 640	a, w
																Q+T					820 to 870	w, o
6	12Ni19	—	0,15	0,35	0,30 to 0,80	0,025	0,020	—	4,50 to 5,30	V ≤ 0,05	≤ 30 30 < t _R ≤ 50	390 380	510 to 710	19	19	N	800 to 850	a	580 to 660	a, w		
																N+T					580 to 660	a, w
																Q+T					540 to 660	a, w
7	X8Ni9	F 45	0,10	0,35	0,30 to 0,80	0,025	0,020	—	8,00 to 10,00	Mo ≤ 0,10 V ≤ 0,05	≤ 30 30 < t _R ≤ 50	490 480	640 to 840	18	18	N+N+T	880 to 930 + 770 to 820	a	540 to 660	a, w		
																Q+T					740 to 820	w, o
																Q+T					540 to 600	a, w

^a All data on designations in this part of ISO 9327 are to be regarded as preliminary (see NOTE 2 of 4.1 in ISO 9327-1:1999).

^b See 5.2.1.1 of ISO 9327-1:1999.

^c R_E is the yield strength (where a yield phenomenon occurs either the upper yield strength R_{EH} or the 0.2 % proof strength shall be recorded);
 R_m is the tensile strength;

A is the percentage elongation after fracture on gauge length;

L_0 is gauge length = $5,65 \sqrt{S_0}$;

DIR: x, y, DIR: x, y and DIR: y, x are the directions of the test piece in relation to the main direction of grain flow. For detailed explanations see Table 5 and Figures 9 and 10 of ISO/TR 15461:1997.

^d The thickness ranges given here apply for the as heat-treated thickness of ruling sections with rectangular cross-section, a width to thickness ratio of ≥ 4 . For ruling sections of other shapes the equivalent thickness shall be determined according to annex A of ISO 9327-1:1999, or be agreed upon at the time of enquiry and order.

NOTE The designer should observe that because of machining allowances, the as heat-treated thickness of the ruling section is normally greater than the finished size.

^e N = normalized (austenitizing with subsequent cooling in air);

T = tempered;

Q = quenched;

f a = air; o = oil; w = water.

Table 2 — Permissible product analysis tolerances on the limiting values given in Table 1 for the cast analysis

Element	Specified limits, cast analysis % by mass	Permissible tolerance ^a % by mass
C	≤ 0,18	+ 0,03
Si	≤ 0,50	+ 0,05
Mn	≤ 1,65	± 0,10
P	≤ 0,025	+ 0,005
S	≤ 0,020	+ 0,005
Al	≥ 0,020	− 0,005
Mo	≤ 0,10	+ 0,03
Ni	≤ 3,75	± 0,07
	≥ 3,75 ≤ 10,0	± 0,10
Nb	≤ 0,05	+ 0,01
V	≤ 0,05	+ 0,01
^a The deviations, other than when maxima only are specified, apply either above or below the specified limits of the range but not both above and below for the same element from different sample products from the same cast. When maxima only are specified, the deviations are positive only. The values are valid only if the samples were selected according to C.5 of ISO 9327-1:1999.		

Table 3 — Impact properties at low temperatures for steels according to Table 1

Line No.	Steel type	Heat treatment ^a	Thickness of the ruling section t_R ^b mm	Test piece direction DIR: ^c	Impact energy KV^d J min.											
					Temperature, °C											
					20	0	− 20	− 40	− 50	− 60	− 80	− 100	− 120	− 150	− 170	− 195
1	11MnNi-5-3,	N +(T)	≤ 50	x-y	70	60	55	50	45	40	—	—	—	—	—	
2	13NnNi6-3			y-x	45	40	40	35	30	27						
3	15NiMn6	N, N +T, Q +T	≤ 50	x-y	65	65	65	60	50	40						
				y-x	45	45	45	40	35	35	27					
4	12Ni14G1,	N, N +T, Q +T	≤ 50	x-y	65	60	55	55	50	50	45	40	—	—	—	
5	12Ni14G2			y-x	45	40	40	35	35	35	30	27				
6	12Ni19	N, N +T, Q +T	≤ 50	x-y	70	70	65	65	65	60	55	45	40 ^e			
				y-x	50	50	45	45	45	40	35	30	27 ^e			
7	X8Ni9	N +N +T, Q +T	≤ 50	x-y	70	70	70	70	70	70	70	60	50	50	45	40
				y-x	50	50	50	50	50	50	50	50	40	35	35	30

^a N = normalized; T = tempered; Q = quenched. For temperatures and cooling conditions see Table 1.

^b See Table 1, footnote d.

^c DIR: x-y Direction of the test piece in relation to the main direction of grain flow.
DIR: y-x For detailed explanations see ISO/TR 15461, Table 5 and Figures 9 and 10.

^d Average of three tests; one of the three individual values may be below the specified minimum average, provided it is no less than 70 % of this value. The values apply to standard 10 mm × 10 mm Charpy V-notch impact test pieces (see ISO 148).

^e For −110 °C.