
Stainless steels — Chemical composition

Aciers inoxydables — Composition chimique

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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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard (“state of the art”, for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until data they provide are considered to be no longer valid or useful.

ISO/TR 15510, which is a Technical Report of type 2, was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 4, *Heat treatable and alloy steels*.

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Printed in Switzerland

This document is being issued in the Technical Report (type 2) series of publications (according to subclause G.3.2.2 of part 1 of the ISO/IEC Directives, 1995) as a “prospective standard for provisional application” in the field of chemical composition of stainless steels because there is an urgent need for guidance on how standards in this field should be used to meet an identified need.

This document is not to be regarded as an “International Standard”. It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the ISO Central Secretariat.

Annexes A and B of this Technical Report are for information only.

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Introduction

In 1991 ISO/TC 17/SC 4 considered it useful to prepare an International Standard for the chemical composition of stainless steels to which those ISO standards with technical delivery conditions for the various stainless steel products (wire, tubes, forgings etc.) and for the various applications (general, pressure purposes etc.) could refer. During the discussions on such a standard it became obvious that, in spite of the existing ISO standards with technical delivery conditions for stainless steels, the chemical compositions and also the mechanical properties specified in the frequently applied national and regional standards showed many technically unjustified or questionable differences. For the elimination of such differences intensive negotiations were initiated between experts on stainless steel of the following organizations:

- the American Society for Testing and Materials (ASTM)
- the European Committee for Iron and Steel Standardization (ECISS) and
- the Japanese Industrial Standards Committee (JISC)

On the basis of these negotiations ISO/TC 17/SC 4 agreed on the chemical compositions given in table 1 and its members promised to undertake all efforts for the implementation of these specifications in their national standards.

However

- only Japan and a minority of the ECISS members declared themselves prepared to take over the specifications given in table 1 in their standards and only when those compositions were approved for ISO Standards;
- a majority of the ECISS-members favoured, when discussing the corresponding European Standard (EN 10088-1), a number of more or less important deviations from the specifications given in table 1;
- ASTM concentrates its efforts on the preparation of a similar national standard but sees for the near future no possibility of implementing the specifications given in table 1 or making constructive proposals for their amendment.

In view of this ISO/TC 17/SC 4 regards it as impossible to bring its attempts for worldwide harmonization of stainless steel specifications to a satisfactory end in the near future. Nevertheless, the data compiled during these negotiations and the specifications proposed by the committee may be useful within work on national or regional standards or when, perhaps at a later date, within ISO, the international harmonization efforts are taken up again. Therefore, the relevant data and results are published in this ISO Technical Report.

Stainless steels — Chemical composition

1 Scope

This ISO Technical Report lists the chemical compositions of stainless steels agreed by ISO/TC 17/SC 4 mainly on the basis of a comparison of the specifications in existing ISO, ASTM, EN and JIS standards. They apply to all product forms including ingots and semi-finished material.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this Technical Report are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 6929:1987, *Steel products — Definitions and classification*.

3 Definitions

For the purposes of this Technical Report the following definition, as well as those given in ISO 6929, applies.

3.1 Stainless steel

Steel with at least 10,5 % Cr and maximum 1,2 % C are considered as stainless steels if their resistance to corrosion is of primary importance.

NOTES

- 1 It is intended to also include in this Technical Report, at a later stage, creep resisting and heat resisting steel grades.
- 2 For the classification of stainless steels according to their structure, composition and application see annex A.

4 Chemical composition

The chemical composition of stainless steels approved by ISO TC 17/SC 4 is given in table 1.

NOTE — If, in special cases, for example an ISO committee charged with the establishment or revision of a standard for a specific product or application of stainless steels sees the necessity of deviating from the specifications in table 1 it should inform ISO/TC 17/SC 4 (Secretariat's address: DIN, Postfach 10 51 45, D-40042 Düsseldorf, Germany) of the reasons for this and try, before such deviations are considered, to achieve consensus for a corresponding modification to table 1.

5 Designations of comparable steels

In table 2 are given the designations of stainless steels which are listed in other international, regional or national standards or designation systems and are comparable to the grades in table 1.

NOTE — It is expected that the compositions specified in these other standards or designation systems will, in the near future, be aligned with those in table 1. (See Introduction.)

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**Table 1 — Internationally agreed specifications for the composition of stainless steels
(applicable for the cast analysis); % (m/m)**

Line	Steel designation	C		Si	Mn		P	S		N		Cr		Mo		Ni		Element	Others	
		min.	max.	max.	min.	max.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.		min.	max.
a) Austenitic steels																				
1	X2CrNi18-9		0,030	1,00		2,00	0,045		1)			0,11	17,50	19,50			8,00	10,00 2)		
2	X2CrNi19-11		0,030	1,00		2,00	0,045		1)			0,11	18,00	20,00			10,00	12,00 2)		
3	X2CrNiN18-9		0,030	1,00		2,00	0,045		1)	0,12	0,22	17,00	19,50				8,00	10,00		
4	X2CrNiN18-7		0,030	1,00		2,00	0,045		0,015	0,12	0,20	16,50	18,50				6,00	8,00		
5	X5CrNi17-7		0,07	1,00		2,00	0,045		1)			0,11	16,00	18,00			6,00	8,00		
6	X5CrNi18-9		0,07	1,00		2,00	0,045		1)			0,11	17,00	19,50			8,00	10,50		
7	X7CrNi18-9	0,04	0,08	1,00		2,00	0,045		1)			0,11	17,00	19,50			8,00	10,50		
8	X6CrNi18-12		0,08	1,00		2,00	0,045		1)			0,11	17,00	19,00			10,50	13,00		
9	X3NiCr18-16		0,04	1,00		2,00	0,045		1)				15,00	17,00			17,00	19,00		
10	X5CrNiN18-8		0,07	1,00		2,50	0,045		0,030	0,10	0,16	17,00	19,50				7,00	10,50		
11	X10CrNi18-8	0,05	0,15	2,00		2,00	0,045		1)			0,11	16,00	19,00		0,80	6,00	9,50		
12	X12CrMnNiN17-7-5		0,15	1,00	5,50	7,50	0,045		1)	0,05	0,25	16,00	18,00				3,50	5,50		
13	X10CrNiS18-9		0,12	1,00		2,00	0,060	0,15				0,11	17,00	19,00			8,00	10,0	Cu	3)
14	X3CrNiCu18-9-4		0,04	1,00		2,00	0,045		1)			0,11	17,00	19,00			8,00	10,50	Cu	3,00
15	X6CrNiTi18-10		0,08	1,00		2,00	0,045		1)				17,00	19,00			9,00	12,00 2)	Ti	5xC
16	X7CrNiTi18-10	0,04	0,08	1,00		2,00	0,045		1)				17,00	19,00			9,00	12,00 2)	Ti	5xC
17	X6CrNiNb18-10		0,08	1,00		2,00	0,045		1)				17,00	19,00			9,00	12,00 2)	Nb	10xC
18	X7CrNiNb18-10	0,04	0,08	1,00		2,00	0,045		1)				17,00	19,00			9,00	12,00 2)	Nb	10xC
19	X2CrNiMo17-12-2		0,030	1,00		2,00	0,045		1)			0,11	16,00	18,00	2,00	3,00	10,00	13,00 2)		
20	X2CrNiMo17-12-3		0,030	1,00		2,00	0,045		1)			0,11	16,50	18,50	2,50	3,00	10,50	13,00 2)		
21	X2CrNiMo19-14-4		0,030	1,00		2,00	0,045		1)			0,11	17,50	20,00	3,00	4,00	12,00	16,00		
22	X2CrNiMoN17-11-2		0,030	1,00		2,00	0,045		1)	0,12	0,22	16,00	18,00	2,00	3,00	10,00	12,50 2)			
23	X2CrNiMoN17-12-3		0,030	1,00		2,00	0,045		1)	0,12	0,22	16,50	18,50	2,50	3,00	10,50	13,00 2)			
24	X2CrNiMoN18-12-4		0,030	1,00		2,00	0,045		1)	0,10	0,20	16,50	19,50	3,00	4,00	10,50	14,00 2)			
25	X2CrNiMoN18-15-5		0,030	1,00		2,00	0,045		1)	0,12	0,22	17,00	20,00	4,00	5,00	13,00	17,00			
26	X5CrNiMo17-12-2		0,07	1,00		2,00	0,045		1)			0,11	16,00	18,00	2,00	3,00	10,00	13,00		
27	X5CrNiMo17-12-3		0,07	1,00		2,00	0,045		1)			0,11	16,50	18,50	2,50	3,00	10,50	13,00 2)		

Table 1 (continued)

Line	Steel designation	C		Si	Mn		P	S		N		Cr		Mo		Ni		Element	Others		
		min.	max.		min.	max.		min.	max.	min.	max.	min.	max.	min.	max.	min.	max.		min.	max.	
a) Austenitic steels																					
28	X6CrNiMoTi17-12-2		0,08	1,00		2,00	0,045		1) ¹⁾			16,50	18,50	2,00	2,50	10,50	13,50 ²⁾	Ti	5xC	0,60	
29	X6CrNiMoNb17-12-2		0,08	1,00		2,00	0,045		1) ¹⁾			16,50	18,50	2,00	2,50	10,50	13,50	Nb	10xC	1,00	
30	X1CrNiMoCuN20-18-7 ⁴⁾		0,020	0,70		1,00	0,035		0,015	0,18	0,25	19,50	20,50	6,00	7,00	17,50	18,50	Cu	0,50	1,00	
31	X1NiCrMoCu25-20-5		0,020	0,75		2,00	0,035		0,015		0,15	19,00	22,00	4,00	5,00	23,50	26,00	Cu	1,20	2,00	
32	X1NiCrMoCuN25-20-7		0,020	0,75		2,00	0,035		0,015	0,15	0,25	19,00	21,00	6,00	7,00	24,00	26,00	Cu	0,50	1,50	
b) Austenitic-ferritic steels																					
33	X2CrNiMoN22-5-3		0,030	1,00		2,00	0,035		0,015	0,10	0,22	21,00	23,00	2,50	3,50	4,50	6,50				
34	X2CrNiMoCuN25-6-3		0,030	0,70		2,00	0,035		0,015	0,15	0,30	24,00	26,00	2,50	4,00	5,00	7,50	Cu	1,00	2,50	
c) Ferritic steels																					
35	X2CrNi12		0,030	1,00		1,50	0,040		0,015		0,030	10,50	12,50			0,30	1,10				
36	X2CrTi12		0,030	1,00		1,00	0,040		1) ¹⁾			10,50	12,50				0,50	Ti	6x(C+N)	0,65	
37	X6CrTi12		0,08	1,00		1,00	0,040		0,030 ⁵⁾			10,50	12,50				0,50	Ti	6x(C+N)	0,65	
38	X6CrNiTi12		0,08	1,00		1,00	0,040		0,015			10,50	12,50			0,50	1,50	Ti	0,05	0,35	
39	X6Cr13		0,08	1,00		1,00	0,040		1) ¹⁾			11,50	14,00				0,75				
40	X6CrAl13		0,08	1,00		1,00	0,040		1) ¹⁾			11,50	14,00					Al	0,10	0,30	
41	X6Cr17		0,08 ⁶⁾	1,00		1,00	0,040		1) ¹⁾			16,00	18,00								
42	X7CrS17		0,09	1,50		1,50	0,040	0,15				16,00	18,00		0,60						
43	X6CrMo17-1		0,08	1,00		1,00	0,040	1) ¹⁾				16,00	18,00	0,90	1,40						
44	X3CrTi17		0,05	1,00		1,00	0,040	1) ¹⁾				16,00	19,00					Ti	4x(C+N)+ 0,20	0,75	
45	X6CrMoNb17-1		0,08	1,00		1,00	0,040		0,015		0,040	16,00	18,00	0,80	1,40			Nb	5xC	1,00	
46	X2CrMoTi18-2		0,025	1,00		1,00	0,040		0,015		0,025	17,00	20,00	1,80	2,50			Ti + Nb	4x(C+N) + 0,20	0,80	
d) Martensitic steels																					
47	X3CrNiMo13-4		0,05	0,70	0,50	1,00	0,040		0,015			12,00	14,00	0,30	1,00	3,50	4,50				
48	X12Cr13	0,08	0,15	1,00	1,50	1,50	0,040		1) ¹⁾			11,50	13,50				0,75				
49	X12CrS13	0,08	0,15	1,00	1,50	1,50	0,040	0,15				12,00	14,00		0,60						
50	X20Cr13	0,16	0,25	1,00	1,50	1,50	0,040		1) ¹⁾			12,00	14,00								

Table 1 (concluded)

Line	Steel designation	C		Si	Mn		P		S		N		Cr		Mo		Ni		Element		Others	
		min.	max.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
51	X30Cr13	0,26	0,35	1,00		1,50	0,040		1 ¹⁾				12,00	14,00								
52	X39Cr13	0,36	0,42	1,00		1,00	0,040		1 ¹⁾				12,50	14,50								
53	X46Cr13	0,43	0,50	1,00		1,00	0,040		1 ¹⁾				12,50	14,50								
54	X52Cr13	0,48	0,55	1,00		1,00	0,040		1 ¹⁾				12,50	14,50								
55	X60Cr13	0,56	0,65	1,00		1,00	0,040		1 ¹⁾				12,50	14,50								
56	X14CrMoS17	0,10	0,17	1,00		1,50	0,040	0,15					16,00	18,00	0,60							
57	X17CrNi16-2	0,12	0,22	1,00		1,50	0,040		0,030				15,00	17,00			1,50	2,50				
e) Precipitation hardening steels																						
58	X5CrNiCuNb16-4		0,07	0,70		1,50	0,040		1 ¹⁾				15,00	17,00		0,60	3,00	5,00	Cu Nb		3,00 5xC	5,00 0,45
59	X7CrNiAl17-7		0,09	0,70		1,00	0,040		0,015				16,00	18,00			6,50	7,80 ⁷⁾	Al		0,70	1,50
60	X8CrNiMoAl15-7-2		0,10	0,70		1,20	0,040		0,015				14,00	16,00	2,00	3,00	6,50	7,80	Al		0,75	1,50

1) For products other than flat products, a sulfur content of maximum 0,030 % applies, unless otherwise agreed (see note 1). For flat products, a maximum sulfur content of 0,015 % applies, unless otherwise agreed. Specially agreed limits may include a maximum sulfur content of up to 0,030 % (see notes 1 and 2).

NOTE 1 For machinability, a controlled sulfur content of 0,015 % to 0,030 % is recommended and permitted.

NOTE 2 For weldability, a minimum sulfur content of about 0,008 % may be beneficial.

2) Where, for special reasons, (e.g., hot workability or low magnetic permeability), it is necessary to minimize the ferrite content, the maximum nickel content may be increased by the following amounts:

- by 0,50 % for steels in lines 1 and 28;
- by 1,00 % for steels in lines 2, 15, 16, 17, 18, 22, 23, 24 and 27;
- by 1,50 % for steels in lines 19 and 20.

3) Copper may be added up to 1,00 %. If added, it must be reported in the inspection document, provided such a document has been ordered.

4) Patented grade.

5) Where machinability is of special importance increased sulfur contents of up to 0,045 % are recommended and permitted.

6) For certain applications, e.g. weldability or high strength wire, a maximum of 0,12 % C may be agreed.

7) By special agreement, the steel when intended for cold deformation may also be ordered with 7,00 % to 8,30 % Ni.

Table 2 — Designations of the steels given in table 1 and of comparable grades covered in various international, regional or national standards or designation systems

Line	Table 1	ASTM/ UNS ²⁾	EN 10088-1:1995		JIS ⁴⁾	CSN ⁵⁾	Steel designations according to ¹⁾							ISO 9328-5:1991
			Name ³⁾	Number ³⁾			ISO 683-13:1986	ISO 683-16:1976	ISO 4954:1993	ISO 4955:1994	ISO 6931-1:1994	ISO 6931-2:1989		
a) Austenitic steels														
1	X2CrNi18-9	S30403	X2CrNi18-9	1.4307	SUS304L	—	10	—	X12CrNi18 10E	—	—	—	X2CrNi18-10	—
2	X2CrNi19-11	S304L?	X2CrNi19-11	1.4306	SUS304L	17249	—	—	—	—	—	—	—	—
3	X2CrNiN18-9	S30453	X2CrNiN18-10	1.4311	SUS304LN	—	10N	—	—	—	—	—	X2CrNiN18-10	—
4	X2CrNiN18-7	S301LN	X2CrNiN18-7	1.4318	SUS301L	—	—	—	—	—	—	—	—	—
5	X5CrNi17-7	S30100	(X3CrNiN17-8)	(1.4319)	SUS301	—	—	—	—	—	—	—	—	—
6	X5CrNi18-9	S30400	X5CrNi18-10	1.4301	SUS304	17240	11	—	X5CrNi18 9 E	—	—	X5CrNi18 10	X5CrNi18-9	—
7	X7CrNi18-9	S30409	(X6CrNi18-10)	(1.4948)	SUS304H	—	—	—	—	X7CrNi18 9	—	—	X7CrNi18-9	—
8	X6CrNi18-12	S30500	X4CrNi18-12	1.4303	SUS305	—	13	—	X5CrNi18 12E	—	—	—	—	—
9	X3NiCr18-16	S38400	—	—	SUS384	—	—	—	X6NiCr18 16E	—	—	—	—	—
10	X5CrNi18-8	S30451	—	—	SUS304N1	—	—	—	—	—	—	—	—	—
11	X10CrNi18-8	S301xx	X10CrNi18-8	1.4310	—	—	14	—	—	—	X9CrNi18-8	X12CrNi17 7	—	—
12	X12CrMnNiN17-7-5	S20100	X12CrMnNiN17-7-5	1.4372	SUS201	—	A-2	—	—	—	—	—	—	—
13	X10CrNiS18-9	S30300	X8CrNiS18-9	1.4305	SUS303	—	17	—	—	—	—	—	—	—
14	X3CrNiCu18-9-4	S30430	X3CrNiCu18-9-4	1.4567	SUSXM7	—	—	—	X3CrNiCu18 9 3E	—	—	—	—	—
15	X6CrNiTi18-10	S32100	X6CrNiTi18-10	1.4541	SUS321	17247	15	—	X6CrNiTi18 10E	—	—	—	X6CrNiTi18-10	—
16	X7CrNiTi18-10	S32109	(X8CrNiTi18-10)	(1.4941)	SUS321H	—	—	—	—	X7CrNiTi18 10	—	—	X7CrNiTi18-10	—
17	X6CrNiNb18-10	S34700	X6CrNiNb18-10	1.4550	SUS347	—	16	—	—	X7CrNiNb18 10	—	—	X6CrNiNb18-10	—
18	X7CrNiNb18-10	S34709	—	—	SUS347H	—	—	—	—	—	—	—	X7CrNiNb18-10	—
19	X2CrNiMo17-12-2	S31603	X2CrNiMo17-12-2	1.4404	SUS316L	17349	19	—	—	—	—	—	X2CrNiMo17-12	—
20	X2CrNiMo17-12-3	S31603	X2CrNiMo17-12-3	1.4432	SUS316L	17350	19a	—	X2CrNiMo17 13 3E	—	—	—	X2CrNiMo17-13	—
21	X2CrNiMo19-14-4	S31703	X2CrNiMo18-15-4	1.4438	SUS317L	—	24	—	—	—	—	—	X3CrNiMo18-16-4	—
22	X2CrNiMoN17-11-2	S31653	X2CrNiMoN17-12-2	1.4406	SUS316LN	—	19N	—	—	—	—	—	X2CrNiMoN17-12	—
23	X2CrNiMoN17-12-3	S3165x	X2CrNiMoN17-13-3	1.4429	SUS316LN	—	19aN	—	X2CrNiMoN17 13 3E	—	—	—	X2CrNiMoN17-13	—
24	X2CrNiMoN18-12-4	S31753	X2CrNiMoN18-12-4	1.4434	SUS317LN	—	—	—	—	—	—	—	—	—
25	X2CrNiMoN18-15-5	S31726	X2CrNiMoN17-13-5	1.4439	—	—	—	—	—	—	—	—	X2CrNiMoN17-13-5	—

Table 2 (continued)

26	X5CrNiMo17-12-2	S31600	X5CrNiMo17-12-2	1.4401	SUS316	17346	20	—	X5CrNiMo17 12 2E	—	X5CrNiMo17-12-2	X5CrNiMo17-12-2
27	X5CrNiMo17-12-3	S31600	X3CrNiMo17-13-3	1.4436	SUS316	17352	20a	—	—	—	—	X5CrNiMo17-13
28	X6CrNiMoTi17-12-2	S31635	X6CrNiMoTi17-12-2	1.4571	SUS316Ti	17348	21	—	X6CrNiMoTi17 12 2E	—	—	X6CrNiMoTi17-12
29	X6CrNiMoNb17-12-2	S31640	X6CrNiMoNb17-12-2	1.4580	—	—	23	—	—	—	—	X6CrNiMoNb17-12
30	X1CrNiMoCu20-18-7	S31254	X1CrNiMoCu20-18-7	1.4547	—	—	—	—	—	—	—	—
31	X1NiCrMoCu25-20-5	N08904	X1NiCrMoCu25-20-5	1.4539	SUS890L	—	A-4	—	—	—	—	X2NiCrMoCu25-20-5
32	X1NiCrMoCuN25-20-7	N08926	X1NiCrMoCuN25-20-7	1.4529	—	—	—	—	—	—	—	—
b) Austenitic-ferritic steels												
33	X2CrNiMoN22-5-3	S31803	X2CrNiMoN22-5-3	1.4462	SUS329J3L	—	—	—	—	—	—	—
34	X2CrNiMoCuN25-6-3	S32550	X2CrNiMoCuN25-6-3	1.4507	SUS329J4L	—	—	—	—	—	—	—
c) Ferritic steels												
35	X2CrNi12	S41050	X2CrNi12	1.4003	—	—	—	—	—	—	—	—
36	X2CrTi12	S40945	X2CrTi12	1.4512	SUH409L	—	—	—	—	—	—	—
37	X6CrTi12	S40900	—	—	SUH409	—	1Ti	—	X6CrTi12E	X6CrTi12	—	—
38	X6CrNiTi12	S409Ni	X6CrNiTi12	1.4516	—	—	—	—	—	—	—	—
39	X6Cr13	S41008	X6Cr13	1.4000	SUS410S	17020	1	—	—	X6Cr13	—	—
40	X6CrAl13	S40500	X6CrAl13	1.4002	SUS405	—	—	—	—	—	—	—
41	X6Cr17	S43000	X6Cr17	1.4016	SUS430	17040	8	—	X6Cr17E	X6Cr17	—	—
42	X7CrS17	S43020	X6CrMoS17	1.4105	SUS430F	—	8a	—	—	—	—	—
43	X6CrMo17-1	S43400	X6CrMo17-1	1.4113	SUS434	—	9c	—	X6CrMo17 1E	—	—	—
44	X3CrTi17	S43035	X3CrTi17	1.4510	SUS430LX	—	8b	—	—	—	—	—
45	X6CrMoNb17-1	S43600	X6CrMoNb17-1	1.4526	—	—	—	—	—	—	—	—
46	X2CrMoTi18-2	S44400	X2CrMoTi18-2	1.4521	SUS444	—	—	—	—	—	—	—
d) Martensitic steels												
47	X9CrNiMo13-4	S41500	X9CrNiMo13-4	1.4313	SUSF6NM	—	—	—	—	—	—	—
48	X12Cr13	S41000	X12Cr13	1.4006	SUS410	17021	3	—	X12Cr13E	—	—	—
49	X12CrS13	S41600	X12CrS13	1.4005	SUS416	—	7	—	—	—	—	—
50	X20Cr13	S4200a	X20Cr13	1.4021	SUS420J1	17022	4	—	—	—	—	—
51	X30Cr13	S4200b	X30Cr13	1.4028	SUS420J2	17023	5	—	—	—	—	—
52	X39Cr13	S4200c	X39Cr13	1.4031	—	17024	—	—	—	—	—	—
53	X46Cr13	S4200d	X46Cr13	1.4034	—	—	—	—	—	—	—	—

Table 2 (concluded)

Line	Table 1	ASTM/ UNS ²⁾	EN 10088-1:1995		JIS ⁴⁾	CSN ⁵⁾	Steel designations according to ¹⁾								
			Name ³⁾	Number ³⁾			ISO 683-13:1986	ISO 683-16:1976	ISO 4954:1993	ISO 4955:1994	ISO 6931-1:1994	ISO 6931-2:1989	ISO 9328-5:1991		
54	X52Cr13	S4200e	—	—	—	—	—	—	—	—	—	—	—	—	—
55	X60Cr13	S4200f	—	—	—	17030	—	—	—	—	—	—	—	—	—
56	X14CrMoS17	S43020	X14CrMoS17	1.4104	—	—	9a	—	—	—	—	—	—	—	—
57	X17CrNi16-2	S43100	X17CrNi16-2	1.4057	SUS431	—	—	—	X19CrNi16 2E	—	—	—	—	—	—
e) Precipitation-hardening steels															
58	X5CrNiCuNb16-4	S17400	X5CrNiCuNb16-4	1.4542	SUS630	—	—	1	—	—	—	—	—	—	—
59	X7CrNiAl17-7	S17700	X7CrNiAl17-7	1.4568	SUS631	—	—	2	—	—	X7CrNiAl17-7	X7CrNiAl17-7	—	—	—
60	X8CrNiMoAl15-7-2	S15700	X8CrNiMoAl15-7-2	1.4532	—	—	—	3	—	—	—	—	—	—	—

NOTE — The grades given in this table are comparable to those given in table 1. However, it should be noted that their chemical compositions may vary.

1) See sources in annex B.

2) Letters or question marks within the UNS-number mean that for the relevant grade a specific UNS-number was not yet known when the work on this ISO Technical Report was finalized.

3) Steel grades given in brackets mean that the steel is not covered in EN 10088-1 but in prEN 10028-7 and/or in the “Stahleisenliste”.

4) Japanese Industrial Standards.

5) Czech Office for Standards.

Annex A (informative)

Classification of grades

Source: EN 10088-1:1995

A.1 Ferritic, semi-ferritic and martensitic steels

Chromium is the main alloying element and the chromium not bound to carbon determines the corrosion resistance.

A.2 Ferritic and semi-ferritic steels

Ferritic steels have a carbon content limit of 0,08 %. Due to this they do not display significant hardening after quenching.

The ferritic structure in α phase (alpha) and δ phase (delta, residual structure from high temperature) is magnetic.

This structure is ductile in specific manufacturing conditions, especially in thin cross sections.

The ferritic free-cutting grades most commonly used for bars include a sulfur addition greater than 0,15 % to facilitate machining. This sulfur addition means a considerable reduction of corrosion resistance.

Ferritic steels have relatively good weldability. A European Standard covering the conditions for welding these materials is in preparation by CEN/TC 121. In general, a low heat-input is advisable to avoid embrittlement grain enlargement.

According to their chemical composition, some grades may undergo a partial martensitic transformation and shall be called semi-ferritic.

A.3 Martensitic steels

Martensitic steels have the highest carbon contents, 0,08 % to over 1 %. Their mechanical strength may be increased considerably by quench heat treatment. The martensitic structure obtained is magnetic and fragile and shall undergo tempering treatment before use.

Some grades include sulphur additions greater than 0,15 % and are for high speed machining.

In addition to the grades defined in this Technical Report, there are grades intended for specific applications. For example, some of the steels specified for bearings are of compositions within the range of stainless steels.

A.4 Precipitation hardening steels

Heat treatment confers a greater mechanical strength on these steels associated with good corrosion resistance.

The increased strength results from the precipitation of intermetallic compounds from the martensitic structure during the final hardening treatment.

The specific heat treatment conditions shall be adjusted depending on the desired level of mechanical properties and the data provided by the manufacturers.

A.5 Austenitic steels

Chromium and nickel are the main elements alloyed with the iron.

The structure of these steels is γ austenite (gamma phase) with the possible presence of δ ferrite (delta phase), residual from high temperatures.

The austenitic γ phase is non magnetic.

Metastable austenite may be transformed into martensite by plastic deformation and/or by cooling at low temperature.

The stability of the austenite may be increased by the addition of austenite forming elements: carbon, nickel, manganese, nitrogen and copper.

Austenitic steels possess good general corrosion resistance. They do not display hardening after any heat treatment; on the other hand, their mechanical strength may be increased by nitrogen additions or by cold forming.

If the steels cool slowly after heat treatment or welding (e. g. in thick sections), chromium carbides precipitate in the grain boundaries in a critical temperature range of approximately 600 °C to 800 °C. This causes intergranular corrosion in contact with acids and other corrosive media.

There are two principal ways of avoiding this problem: by alteration to chemical analysis given in A.5 c) and d).

Austenitic steels have a good weldability. A European Standard covering the conditions for welding these materials is in preparation by CEN/TC 121.

Austenitic steels have good toughness properties including at low temperatures and high resistance to brittle fracture.

According to the carbon content and the alloying elements, austenitic steels may be classified into the following:

a) Austenitic steels without molybdenum

These are the grades most commonly used because they represent a good compromise between cost and corrosion resistance.

They are more difficult to machine than the ferritic and martensitic grades and as in those categories, there are resulfurized variants ($S \geq 0,15 \%$). This sulphur addition means a considerable reduction of corrosion resistance.

b) Austenitic molybdenum steels

The addition of molybdenum in general improves the corrosion resistance, especially against chloride induced pitting.

Higher sulfur contents may impair this effect.

In nitric acid and nitrous gas environments molybdenum additions are rather unfavourable.

c) Extra low carbon austenitic steels

One method of avoiding intergranular corrosion is to make steels with carbon $\leq 0,030$ %, in which case all the carbon remains in solid solution, and it therefore does not combine with chromium to form chromium-carbide precipitates.

d) Stabilized austenitic steels

The addition of titanium and/or niobium prevents the precipitation of chromium carbides linked to heat treatment and/or welding processes. Furthermore, these steels display good strength properties up to about 600 °C.

e) Super austenitic steels

These steels are enriched in chromium and molybdenum contents and have a completely austenitic structure due to higher nickel and nitrogen contents. They have an excellent corrosion resistance in aggressive environments.

Up to the 1960s the stabilized steel 'solution' to this problem was preferred, as it was difficult, expensive and unreliable to refine extra low carbon steels in the electric arc furnace.

However, the technological advances in stainless steelmaking since then have enabled extra low carbon steels to be made more cheaply, quickly and reliably than stabilized grades.

On the other hand, the stabilized grades have higher strength at elevated temperatures.

Further advice on steel selection is available from manufacturers. Whichever 'solution' is chosen, the steel will be melted and processed to be free from the risk of intergranular corrosion in the delivery condition, and there should be no need to specify intercrystalline corrosion testing in most purchase specifications.

A.6 Austenitic-ferritic (Duplex) steels

These steels usually have a high chromium and low nickel content, with the distinctive feature of displaying a two-phase structure at room temperature (austenite content lying between 40 % and 60 %).

Their strength properties are higher than those of austenitic steels.

These steels have an especially good resistance to stress corrosion.

A.7 Creep resisting steels

Variants of the steels described by clauses A.1 to A.6, often with an increased carbon content, are used as creep resisting steels.

A.8 Heat resisting steels

These ferritic or austenitic types of steels are used in part for their excellent resistance to oxidation and to corrosion by high temperature gases and also for retaining their mechanical properties over a wide range of temperatures.

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