

GENERAL STANDARD**FOR****CORROSION RESISTANT ALLOY SEAMLESS TUBES****FOR****USE AS CASING, TUBING AND COUPLING STOCK (CRA)****ORIGINAL EDITION****SEPTEMBER 2015**

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS are based on internationally acceptable standards and include selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein.

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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GENERAL DEFINITIONS

Throughout this Standard the following definitions shall apply.

COMPANY :

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER :

Means the "Company" where this standard is a part of direct purchaser order by the "Company", and the "Contractor" where this Standard is a part of contract document.

VENDOR AND SUPPLIER :

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR :

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR :

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR :

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL :

Is used where a provision is mandatory.

SHOULD :

Is used where a provision is advisory only.

WILL :

Is normally used in connection with the action by the "Company" rather than by a contractor, supplier or vendor.

MAY :

Is used where a provision is completely discretionary.

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0. INTRODUCTION

This Standard specification gives the amendments and supplements to API Standard 5CRA, First Edition, Feb. 2010, "Specification for Corrosion Resistant Alloy Seamless Tubes for Use as Casing, Tubing and Coupling Stock"

Guidance for Use of this Specification

The amendments/supplement to API Standard 5CRA given in this Standard are directly related to the equivalent sections or clauses in API Standard 5CRA. For clarity, the section and paragraph numbering of API Standard 5CRA has been used as far as possible.

Where clauses in API are referenced within this Standard, it shall mean those clauses are amended by this Standard. Clauses in API that are not amended by this Standard shall remain valid as written.

The following annotations, as specified hereunder, have been used at the bottom right hand side of each clause or paragraph to indicate the type of change made to the equivalent clause or paragraph of API.

Sub. (Substitution) "The clause in API Spec. 5CRA shall be deleted and replaced by the new clause in this Specification"

Del. (Deletion) "The clause in API Spec. 5CRA shall be deleted without any replacement"

Add. (Addition) "The new clause with the new number shall be added to the relevant section of API Spec. 5CRA "

Mod. (Modification) "Part of the clause or paragraph in API Spec. 5CRA shall be modified and/or the new description and/or statement shall be added to that clause or paragraph as given in this Specification"

1. SCOPE

The following sentence shall be added at the end of the paragraph.

Note 4: This standard has been prepared by special committee and the committee will reviewed and updated it, later. **(Add.)**

2. CONFORMANCE

2.2 Units of Measurement

This Standard is based on International System of Units (SI), as per [IPS-E-GN-100](#) except where otherwise specified. **(Sub.)**

3. NORMATIVE REFERENCES

API (AMERICAN PETROLEUM INSTITUTE) (Add.)

API 5C3/ISO 10400 "Technical Report on equations and calculations for casing, tubing and line pipe used as casing or tubing; and performance for properties table for casing and tubing"

ASTM (AMERICAN SOCIETY FOR TESTING OF MATERIALS) (Add.)

- ASTM B668-14 "Standard Specification for UNS N08028 Seamless Pipe and Tube"
- ASTM E165 "Standard Practice for Liquid Penetrant Examination for General Industry"
- ASTM A530 "Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe"
- ASTM A 450 "Standard Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes¹"
- ASTM B668 "Standard specification for UNS N08028 seamless pipe and tube"

ASNT (AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING)

- ASNT SNT-TC-1A "Recommended Practice—Non-Destructive Testing" **(Del.)**
- ASNT SNT-TC-1A "Recommended Practice: Personnel Qualification and Certification in Non-Destructive Testing" **(Mod.)**

BSI (BRITISH STANDARDS INSTITUTION) (Add.)

- BS EN ISO 9712 "Non-Destructive Testing-Qualification and Certification of NDT Personnel-General Principals"
- BS EN 10233 "Metallic Materials-Tube - Flattening Test"
- BS EN 10088-3 "Stainless steels .Technical delivery conditions for semi-finished products, bars, rod, wire, sections and bright products of corrosion resisting steels for general purposes"

IPS (IRANIAN PETROLEUM STANDARDS)

(Add.)

[IPS-E-GN-100](#) "Engineering Standard for Units"

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

ISO 31-0	"Quantities and Units — Part 0: General Principles"	(Del.)
ISO 80000-1	"Quantities and Units — General Principle"	(Sub.)
ISO 783	"Metallic Materials — Tensile Testing at Elevated Temperature"	(Del.)
ISO 6892-2	"Metallic Materials — Tensile Testing at Elevated Temperature"	(Sub.)
ISO 6892	"Metallic Materials — Tensile Testing at Ambient Temperature"	(Del.)
ISO 6892-1	"Metallic Materials — Tensile Testing: Method of Test at Room Temperature"	(Sub.)
ISO 9303	"Seamless and Welded (Except Submerged Arc-Welded) Steel Tubes for Pressure Purposes — Full Peripheral Ultrasonic Testing for the Detection of Longitudinal Imperfections"	(Del.)
ISO 10893-10	"Non-Destructive Testing of Steel Tubes. Automated Full Peripheral Ultrasonic Testing of Seamless and Welded (Except Submerged Arc-Welded) Steel Tubes for the Detection of Longitudinal and/or Transverse Imperfections"	(Sub.)
ISO 9304	"Seamless and Welded (Except Submerged Arc-Welded) Steel Tubes for Pressure Purposes — Eddy Current Testing for the Detection of Imperfections"	(Del.)
ISO 10893-2	"Non-Destructive Testing of Steel Tubes. Automated Eddy Current Testing of Seamless and Welded (Except Submerged Arc-Welded) Steel Tubes for the Detection of Imperfections"	(Sub.)
ISO 9402	"Seamless and Welded (Except Submerged Arc-Welded) Steel Tubes for Pressure Purposes — Full Peripheral Magnetic Transducer/Flux Leakage Testing of Ferromagnetic Steel Tubes for the Detection of Longitudinal Imperfections"	(Del.)
ISO 10893-3	"Non-Destructive Testing of Steel Tubes. Automated Full Peripheral Flux Leakage Testing of Seamless and Welded (Except Submerged Arc-Welded) Ferromagnetic Steel Tubes for the Detection of Longitudinal and/or Transverse Imperfections"	(Sub.)
ISO 10124	"Seamless and Welded (Except Submerged Arc-Welded) Steel Tubes for Pressure Purposes — Ultrasonic Testing for the Detection of Laminar Imperfections"	(Del.)
ISO 10893-8	"Non-Destructive Testing of Steel Tubes. Automated Ultrasonic Testing of Seamless and Welded Steel Tubes for the Detection of Laminar Imperfections"	(Sub.)
ISO 10543	"Seamless and Hot-Stretch-Reduced Welded Steel Tubes for Pressure Purposes — Full Peripheral Ultrasonic Thickness Testing"	(Del.)
ISO 10893-12	"Non Destructive Testing of Steel Tubes. Automated Full Peripheral Ultrasonic Thickness Testing of Seamless and Welded (Except Submerged Arc-Welded) Steel Tubes"	(Sub.)

ISO 12095	“Seamless End Welded Steel Tubes for Pressure Purposes — Liquid Penetrant Testing”	(Del.)
ISO 10893-4	“Non- Destructive Testing of Steel Tubes. Liquid Penetrant Inspection of Seamless and Welded Steel Tubes for the Detection of Surface Imperfections”	(Sub.)
ISO 13665	“Seamless and Welded Steel Tubes for Pressure Purposes — Magnetic Particle Inspection of the Tube Body for the Detection of Surface Imperfections”	(Del.)
ISO 10893-5	“Non-Destructive Testing of Steel Tubes. Magnetic Particle Inspection of Seamless and Welded Ferromagnetic Steel Tubes for the Detection of surface Imperfections”	(Sub.)
ISO 9305	“Seamless Steel Tubes for Pressure Purposes - Full Peripheral Ultrasonic Testing for the Detection of Transverse Imperfections”	(Del.)
ISO 9598	“Seamless steel tubes for pressure purposes - Full Peripheral Magnetic transducer/flux leakage testing of ferromagnetic steel tubes for the detection of transverse imperfections”	(Del.)
ISO 11496	“Seamless and Welded Steel Tubes for Pressure Purposes - Ultrasonic Testing of Tube Ends for the Detection of Laminar Imperfections”	(Del.)
ISO 15156-3:2003	“Petroleum and Natural Gas Industries — Materials for Use in H ₂ S-Containing Environments in Oil and Gas Production — Part 3: Cracking-Resistant CRAs (Corrosion Resistant Alloys) and other Alloys”	(Del.)
ISO 15156-3:2005	“Petroleum and Natural Gas Industries — Materials for Use in H ₂ S-Containing Environments in Oil and Gas Production — Part 3: Cracking-Resistant CRAs (Corrosion Resistant Alloys) and other Alloys — Technical Corrigendum 1”	(Del.)
ISO 15156-3:2005	“Petroleum and Natural Gas Industries — Materials for use in H ₂ S-Containing Environments in Oil and Gas Production — Part 3: Cracking-Resistant CRAs (Corrosion Resistant Alloys) and other Alloys — Technical Corrigendum 2”	(Del.)

7. MATERIAL REQUIREMENTS

7.1 Chemical Composition

In Table A.2 or Table C.2, generic types of alloy are listed with their nominal content of key chemical elements for PSL-1 products.

In Table A.28 or Table C.28, the chemical analysis for alloy for PSL-2 products is listed.

For PSL-1 products, the chemical composition and tolerances, as agreed between purchaser and manufacturer, shall be included in the purchase agreement.

For group 2 material only, products in accordance with this International Standard shall have a pitting-resistance equivalent number as stated in Table A.2 or Table C.2 for PSL-1 products or in Table A.28 or Table C.28 for PSL-2 products. For alloy UNS N08028 the minimum PRE No. shall be 36 in the Persian Gulf Area.

(Mod.)

7.7 Flattening Requirements

The second part of the last paragraph shall be amended as follows (other parts remain unchanged):

When the D/t ratio is outside the above limits, the required flattening shall be by agreement between the purchaser and manufacturer.

“As a guide (ExxonMobil) formula $S=D(1.08-.03D/t)$ in US customary units, which is the corresponding distance between the upper and lower platens (plates) of the testing machine can be used with the following acceptance criteria:

A load drop-off that exceeds 5 % of the instantaneous load prior to the drop-off shall be cause for rejection. No cracks are permitted in any portion of the specimen. Cracks that are visible with dye penetrant testing, according to ASTM E165, after completion of the test shall result in rejection of the tube and lot from which the ring specimen was taken. Manufacturer shall report the occurrence and results of all retests and rejects.”

Occurrence of a load drop-off, before meeting the specified deflection, shall be determined from the load versus deflection test record. When the record does not show a load drop-off above 5 %, cracks shall not be cause for rejection. **(Mod.)**

7.8 Corrosion Properties

The existing paragraph shall be replaces with the following:

7.8.1 Manufacture qualification

Corrosion testing is mandatory for manufacturer qualification unless otherwise specified by the purchaser. Corrosion tests may be specified from the following list:

- a) The critical pitting temperature (CPT) test, in accordance with ASTM G48 method C.
- b) The pitting corrosion resistance test, in accordance with ASTM G48 method A.
- c) The critical crevice temperature (CCT) test, in accordance with ASTM G48 method D.
- d) The crevice-corrosion-resistance test, in accordance with ASTM G78.
- e) Mass loss tests to determine general corrosion rate, in accordance with ASTM G31.
- f) The C-ring test, in accordance with ISO 7539-1 and ISO 7539-5. Test duration shall be at least 720 hours.
- g) The slow strain-rate test, in accordance with NACE TM0198.
- h) Inter-granular Corrosion test accordance with ASTM G28 or equivalent international standard.
- i) GHSC, SSC and SCC tests according to NACE MR0175/ISO15156-3.

7.8.2 Product quality control

Slow strain rate test (SSRT) is mandatory in accordance with purchaser requirement. **(Mod.)**

7.12 Hydrostatic Test

The first sentence of this clause shall be replaced by the following sentence:

All CH, HF, SA, and QT pipe shall be hydrostatically tested unless otherwise specified on the purchase agreement. **(Mod.)**

The second sentence shall be deleted:

CH pipe shall be tested if agreed upon between purchaser and manufacturer. **(Del.)**

8. DIMENSIONS, MASSES AND TOLERANCES

8.1 Outside Diameter, Wall Thickness and Mass

The following sub-section shall be added at the end of this section:

8.1.4 Ovality

Ovality should be measured with an API ovality gauge or equivalent. Readings should be taken over all circumferential positions: measurements at equally spaced intervals (e.g. 45°) are not acceptable. Ovality should be calculated as:

$$\frac{OD_{max} - OD_{min}}{OD_{max} + OD_{min}} \leq 0.6\% \quad \text{(Add.)}$$

9. INSPECTION AND TESTING

9.14 Hydrostatic Test

The following sentence shall be added at the end of paragraph.

Final washing in clean water with chloride ion content (mass fraction) of less than 50 mg/l.

(Add.)

9.16 Non-Destructive Examination

9.16.1 General

The third paragraph shall be replaced with the following:

The artificial reference indicators of table A.22 or Table C.22 shall be oriented at three orientations of longitudinal, transverse and an angle such that detection of defects typical of the manufacturing process is optimized. The technical justification for modification of the orientation shall be documented.

(Mod.)

9.16.2 NDE personnel

The existing clause shall be replaced with the following:

All NDE operations (except visual inspection) referred to in this International Standard shall be conducted by NDE personnel qualified in accordance with ISO 11484, ISO 9712 or ASNT SNT-TC-1A, under the responsibility of level 3 certified personnel according to ASNT SNT-TC-1A or equivalent.

(Mod.)

9.16.5 Untested ends

The existing paragraph shall be replaced with the following:

In many of the automatic NDE operations specified in this International Standard, there can be a short length at both ends which cannot be tested. In such cases, one of the following actions shall be performed on the untested ends

- a) cropped off,
- b) subjected to a manual/semi-automatic test achieving, as a minimum, the same degree of inspection as the automatic NDE (ISO 11496),

- c) for group 1, subjected to magnetic particle inspection of the outside and inside surfaces around the full periphery and over the length of the untested ends,
- d) for groups 2, 3 and 4, subjected to liquid-penetrant inspection of the outside and inside surfaces around the full periphery and over the length of the untested ends. **(Mod.)**

9.16.13 Disposition of pipe containing defects

- a) Grinding or machining:

The existing sub-clause (1, 2, 3) shall be replaced with the following:

1) the same inspection unit at the same sensitivity that performed the initial inspection, along with liquid-penetrant inspection according to ISO 12095 or ASTM E165 or for group 1, magnetic-particle inspection according to ISO 13665 or ASTM E709,

or

2) Another NDE method, or combination of methods, that demonstrates equal or greater sensitivity than the original NDE.

When method 2) above is used, the NDE method (or combination of methods) shall be documented and shall demonstrate equal or greater sensitivity than the original NDE. In addition, method 2) shall address the possibility that there can be other coincident defects in the affected area. **(Mod.)**

9.16.14 Disposition of pipe containing defects

- a) Grinding or machining:

The existing sub-clause (1, 2, 3) shall be replaced with the following:

1) The same inspection unit at the same sensitivity that performed the initial inspection, along with liquid-penetrant inspection according to ISO 12095 or ASTM E165 or for group 1, magnetic particle inspection according to ISO 13665 or ASTM E709,

or

2) Another NDE method, or combination of methods, that demonstrates equal or greater sensitivity than the original NDE.

When method 2) above is used, the NDE method (or combination of methods) shall be documented and shall demonstrate equal or greater sensitivity than the original NDE. In addition, method 2) shall address the possibility that there may be other coincident defects in the affected area. **(Mod.)**

10. SURFACE TREATMENT

10.2 Groups 2, 3 and 4

The existing sentence shall be replaced with the following:

- Final washing in clean water with chloride ion content (mass fraction) of less than 50 mg/l.

(Mod.)

11.2 Marking on the product

The following paragraph shall be added to this section:

Marking materials shall be free of harmful contaminants such as halogens, sulfur, chloride, lead, zinc, and other low melting points metals.

Each product, billet, ingot or hollow etc., shall be identified with a unique identification number with the number being maintained through all production processes tests, and inspections. **(Add.)**

13.3 Test Certificates

The existing part shall be amended as follows (other parts remain unchanged):

l) Statement of compliance to each of the dimensional requirements, which includes diameter, wall thickness, drift, length, straightness, out-of-roundness, mass and product ends (plain end out-of-squareness). **(Mod.)**

**ANNEX A
(NORMATIVE)
TABLES IN SI UNITS**

The existing title of tables shall be replaced with the following:

**TABLE A.2 — PSL-1 PRODUCT GENERIC ANALYSIS OF CORROSION-RESISTANT ALLOY
AND MATERIAL CATEGORIES (Mod.)**

**TABLE A.3 — PSL-1 PRODUCT MECHANICAL PROPERTIES AT ROOM TEMPERATURE
(Mod.)**

The existing table shall be replaced by:

TABLE A.20 — TYPE AND FREQUENCY OF TESTS FOR NON-UPSET AND UPSET PRODUCT (Mod.)

Type of test or requirements	Test requirements ^a	Frequency of testing ^b	Test methods	Requirements
1	2	3	4	5
Cast analysis	m ^d	1 per cast	9.3.2	7.1
Product analysis	Non-remelted alloy	2 per cast	9.3.2	7.1
	Remelted alloy	1 per ingot	9.3.2	7.1
Room-temperature tensile test	m ^d	1 per test lot ^c	9.5.2	7.2
Elevated-temperature tensile test	o ^d	1 per test lot ^c	9.5.2	7.2
Hardness test	m ^d	1 series/ test lot ^c	9.6.2	7.3
Impact or flattening test	m ^d	9.7.2	9.7.3 or 9.7.4.1	7.4, 7.5, 7.6, 7.7
Microstructure examination	m ^d	1 per test lot ^c	9.8.2	7.9
Visual inspection	m	Each product	9.15	7.10, 7.11, 8.4
Hydrostatic test	m ^d	Each pipe	9.14	7.12
Dimensional testing:				
— Outside diameter	m	Each end	9.9.2	Table A.15 and Table A.17
— Wall thickness	m	Each end	9.9.3	Table A.15 and Table A.17
— Drift test ^e	m	Each pipe	9.10	Table A.15 and Table A.18 or Table A.19
— Length	m	Each product	9.11	Table A.16
— Straightness	m	Each pipe	9.12	8.3.3
— Mass	m	Each product	9.13	Table A.15 and Table A.17
Non-destructive examination:				
— UT for longitudinal defects	m ^d	Each product	9.16	7.11
— UT for transverse defects	m ^d	Each product	9.16	7.11
— UT for angular defects	m ^d	Each product	9.16	7.11
— UT for laminar defects	m ^d	Each product	9.16	7.11
— UT for wall thickness ^e	m ^d	Each product	9.16	7.11
— UT manual on upset L+T ^e	m ^d (o ^f) ^d	Each product	9.16	7.11
— EMI ^e	o ^{d,f}	Each product	9.16	7.11
— Liquid penetrant inspection	m (o ^f)	Only ground or machined area	9.16	7.11
— MT	o ^f (m ^g)	Only ground or machined area	9.16	7.11
^a “m” signifies mandatory; “o” signifies optional (an agreement is required). ^b For definition of “test lot”, see 4.1.19. See Table A.21 for the maximum number of product in a test lot. ^c Minimum 1 per cast. ^d It is required that records be retained. ^e Not applicable to coupling stock. ^f Option for group 1 only. ^g Mandatory for upset ends of group 1.				

The existing table shall be replaced by:

TABLE A.22 — ARTIFICIAL REFERENCE INDICATOR

Acceptance inspection level	Notch depth ^a max.	Notch length (max. at full depth) ^e		Width max.	Radially drilled hole diameter ^b
		1	2		
L2	5 % ^c	CH/Machined tubes	others	1 mm ^d	1,6 mm
		25 mm	50 mm		

- a Depth as a percent of specified wall thickness. The minimum notch depth shall be 0,1 mm for cold drawn cold pilgered or machined tubes and 0,3 mm for all the other conditions. The tolerance on notch depth shall be $\pm 15\%$ of reference notch depth or $\pm 0,05$ mm whichever is the greater, with the exception that when the notch depth is less than 0,3 mm, the tolerance shall be $\pm 0,03$ mm.
- b Drilled hole diameter (through the pipe wall) shall be based on the drill bit size.
- c The maximum depth of notch for all acceptance levels and subcategories shall be 1,5 mm.
- d The width of the reference notch shall not be greater than 1,0 mm and should not exceed twice the depth.
- e Unless otherwise specified by the product standard or agreed on by the purchaser and manufacturer, the length of the reference notch(es) shall be greater than the width of the single transducer or single virtual transducer.

(Mod.)

The existing table shall be replaced by:

**TABLE A.27 — PSL-2 PRODUCT MECHANICAL PROPERTIES AT ROOM TEMPERATURE
(SI UNITS) (Mod.)**

Material identity from Table A.2		UNS number	Grade	Delivery condition	Yield strength ^f $R_{p0,2}$ Mpa		Tensile strength ^a R_m MPa	Elongation ^b e %	Mean hardness number ^f HRC
Group	Category				min.	max.	min.	min.	max.
1	2	3	4	5	6	7	8	9	10
1	13-5-2	S41426 ^c	80	QT	552	655	621	b	27
			95	QT	655	724	724		27
2	22-5-3	S31803 ^d	65	SA	448	621	621	25	26
			110	CH	758	965	862	11	36
			125	CH	862	1 000	896	10	36
	25-7-3	S31260 ^d	75	SA	517	689	621	25	26
			110	CH	758	965	862	11	36
			125	CH	862	1 000	896	10	36
	25-7-4	S32750 ^d	80	SA	552	724	758	20	28
			90	SA	621	724	793	20	30
			110	CH	758	965	862	12	36
			125	CH	862	1 000	896	10	36
		S32760 ^d	80	SA	552	724	758	20	28
			90	SA	621	724	793	20	30
S39274 ^d	110	CH	758	965	862	12	36		
	125	CH	862	1 000	896	10	36		
	80	SA	552	724	758	20	28		
	90	SA	621	724	793	20	30		
3	27-31-4	N08028 ^e	110	CH	758	965	793	12	33
			125	CH	862	1 000	896	12	35
	25-32-3	N08535 ^e	110	CH	758	965	793	12	33
			125	CH	862	1 000	896	12	35
	22-35-4	N08135 ^e	110	CH	758	965	793	12	33
	4	21-42-3	N08825 ^e	110	CH	758	965	793	11
125				CH	862	1 000	896	10	35
22-50-7		N06985 ^e	110	CH	758	965	793	11	35
			125	CH	862	1 034	896	10	37
25-50-6		N06255 ^e	110	CH	758	965	793	11	35
			125	CH	862	1 034	896	10	37
		N06975 ^e	110	CH	758	965	793	11	35
			125	CH	862	1 034	896	10	37
20-54-9		N06950 ^e	110	CH	758	965	793	11	35
			125	CH	862	1 034	896	10	37
15-60-16	N10276 ^e	110	CH	758	965	793	11	35	
		125	CH	862	1 034	896	10	37	
		140	CH	965	1 103	1 000	9	38	

^a See requirement in 7.2 for relation between tensile and yield strength.

$$e = 1.944 \frac{A^{0.2}}{R_m^{0.9}}$$

where

- e is the minimum elongation in 50,8 mm gauge length, expressed in percent;
- A is the cross-sectional area of the tensile test specimen, expressed in square millimetres based on specified outside diameter or nominal specimen width and specified wall thickness, rounded to the nearest 10 mm², or 490 mm², whichever is smaller;
- R_m is the specified minimum tensile strength, expressed in megapascals.

^c From ISO 15156-3:2003 and ISO 15156-3:2003/Cor 1:2005, Table D.6.

^d From ISO 15156-3:2003 and ISO 15156-3:2003/Cor 1:2005, Table D.7.

^e From ISO 15156-3:2003 and ISO 15156-3:2003/Cor 1:2005, Table D.3.

^f Other values may be agreed between purchaser and manufacturer, subject to the requirements in Clause G.2.

The existing table shall be replaced by:
TABLE A.28 — PSL-2 CHEMICAL COMPOSITION OF CORROSION-RESISTANT ALLOY AND MATERIAL CATEGORIES (SI UNITS) (Mod.)

Material identity from Table A.2			UNS number	Chemical composition maximum % mass fraction or range, unless otherwise indicated														PRE ^b Range No.			
Group	Structure	Category ^a		C	Cr	Ni	Fe ^c	Mn	Si	Mo	Co	Cu	P	S	Ti	Nb + Ta	V		W	N	Al
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	Martensitic	13-5-2	S41426 ^d	0,03	11,5 to 13,5	4,5 to 6,5	bal.	0,5 to 3	0,5 to 1	1,5 to 3	—	—	0,02	0,005 to 0,5	—	—	0,5	—	—	—	NA
2	Duplex austenitic/ferritic	22-5-3	S31803 ^e	0,03	21,0 to 23,0	4,5 to 6,5	bal.	2	1	2,5 to 3,5	—	—	0,03	0,02	—	—	—	—	0,08 to 0,20	—	35 to 40
		25-7-3	S31260 ^e	0,03	24,0 to 26,0	5,5 to 7,5	bal.	1	0,75 to 1	2,5 to 3,5	—	0,20 to 0,80	0,03	0,03	—	—	—	0,10 to 0,50	0,10 to 0,30	—	37,5 to 40
	Super duplex austenitic/ferritic	25-7-4	S32750 ^e	0,03	24,0 to 26,0	6,0 to 8,0	bal.	1,2 to 4,0	0,8 to 1	3,0 to 4,0	—	—	—	0,035	0,02	—	—	—	—	0,24 to 0,32	—
S32760 ^e			0,03	24,0 to 26,0	6,0 to 8,0	bal.	1	1	3,0 to 4,0	—	0,5 to 1,0	0,03	0,03	0,01	—	—	—	0,5 to 1,0	0,2 to 0,3	—	40 to 45
3	Austenitic Fe base	27-31-4	S39274 ^e	0,030	24,0 to 26,0	6,0 to 8,0	bal.	1	0,8 to 1	2,5 to 3,5	—	0,20 to 0,80	0,030	0,02	—	—	—	1,50 to 2,50	0,24 to 0,32	—	40 to 45
			N08028 ^f	0,03	26,0 to 28,0	30 to 32,5	bal.	2,50 to 4,0	1,00 to 1,4	3,0 to 4,0	—	0,6 to 1,4	0,030	0,030	0,030	—	—	—	—	—	—
		25-32-3	N08535 ^f	0,030	24,0 to 27,0	29,0 to 36,5 g	bal.	1,00 to 4,0	0,50 to 1,0	2,5 to 4,0	g	1,50	0,03	0,03	0,03	—	—	—	—	—	—
22-35-4	N08135 ^f	0,03	20,5 to 23,5	33,0 to 38,0	bal.	1,0 to 5,0	0,75 to 1,0	4,0 to 5,0	—	0,70	0,03	0,03	0,03	—	—	—	0,2 to 0,8	—	—	—	NA

**ANNEX C
(NORMATIVE)
TABLES IN USC UNITS**

The existing title of tables shall be replaced with the following:

TABLE C.2 — PSL-1 PRODUCT GENERIC ANALYSIS OF CORROSION-RESISTANT ALLOY AND MATERIAL CATEGORIES (Mod.)

TABLE C.3 — PSL-1 PRODUCT MECHANICAL PROPERTIES AT ROOM TEMPERATURE (Mod.)

The existing table shall be replaced by:

TABLE C.19 — ALTERNATE DRIFT MANDREL DIMENSIONS

Label 1	Label 2	Outside diameter <i>D</i> in	Wall thickness <i>t</i> in	Drift mandrel size minimum		Mass plain end lb/f
				Length in	diameter in	
1	2	3	4	5	6	7
7	23.00	7.000	0.317	6	6.250	22.6
7	32.00	7.000	0.453	6	6.000	31.7
7- ³ / ₄	46.10	7.750	0.597	6	6.500	45.5
8- ⁵ / ₈	32.00	8.625	0.352	6	7.875	31.1
8- ⁵ / ₈	40.00	8.625	0.450	6	7.625	39.3
9- ⁵ / ₈	40.00	9.625	0.395	12	8.750	38.9
9- ⁵ / ₈	53.50	9.625	0.545	12	8.500	52.9
9- ⁵ / ₈	58.40	9.625	0.595	12	8.375	57.4
10- ³ / ₄	45.50	10.750	0.400	12	9.875	44.2
10- ³ / ₄	55.50	10.750	0.495	12	9.625	54.2
11- ³ / ₄	42.00	11.750	0.333	12	11.000	40.6
11- ³ / ₄	60.00	11.750	0.489	12	10.625	58.8
11- ³ / ₄	65.00	11.750	0.534	12	10.625	64.0
13- ³ / ₈	72.00	13.375	0.514	12	12.250	70.6

(Mod.)

**ANNEX E
(NORMATIVE)
CLEANLINESS REQUIREMENTS**

The existing table shall be replaced by:

TABLE E.3 — MICROSCOPIC CLEANLINESS ACCEPTANCE LIMITS

Inclusions ^a	Severity (maximum)	
	Heavy	Thin
Type A (sulfide)	1,0	1,0
Type B (aluminium)	1,5	1,5
Type C (silicate)	1,0	1,0
Type D (globular)	1,5	1,5

^a Other features, anomalies or gross defects noted by the inspector/metallurgist while reviewing the microetched material either shall result in rejection, or shall be allowed a retest, or shall be brought to the attention of the purchaser for resolution.

(Mod.)