

GENERAL STANDARD
FOR
MANUFACTURING AND SUPPLYING CORROSION RESISTANT ALLOYS
SEAMLESS TUBES
FOR
USE AS CASING, TUBING AND COUPLING STOCK

FIRST EDITION

AUGUST 2018

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.

Deputy of Standardization, Administrative of Technical, Execution and Evaluation of Projects Affairs, No.17, St. 14th, North Kheradmand, Karimkhan Blvd., Tehran, Iran.

Postal Code- 1585886851

Tel: 88810459-60 & 66153055

Fax: 88810462

Email: Standards@nioc.ir

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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PART I**1. INTRODUCTION**

This Standard specification gives the amendments and supplements to ANSI/API Specification 5CRA, First Edition, Feb. 2010 (Reaffirmed, APRIL 2015), "Specification for Corrosion Resistant Alloy Seamless Tubes for Use as Casing, Tubing and Coupling Stock".

1.1 SCOP

This Standard specifies the technical delivery conditions for corrosion-resistant alloy seamless tubulars for casing, tubing and coupling stock for two product specification levels:

□ PSL-1, which is the basis of this Standard;

□ PSL-2, which provides additional requirements for a product that is intended to be both corrosion resistant and cracking resistant for the environments and qualification method specified in ISO 15156-3 and Annex G of API 5CRA.

At the option of the manufacturer, PSL-2 products can be provided in lieu of PSL-1.

Note 1: The corrosion-resistant alloys included in this Standard are special alloys in accordance with ISO 4948-1 and ISO 4948-2.

This Standard is applicable to the following four groups of product:

- a) group 1, which is comprised of stainless alloys with a martensitic or martensitic/ferritic structure;
- b) group 2, which is comprised of stainless alloys with a ferritic-austenitic structure, such as duplex and super duplex stainless alloy;
- c) group 3, which is comprised of stainless alloys with an austenitic structure (iron base);
- d) group 4, which is comprised of nickel-based alloys with an austenitic structure (nickel base).

This Standard contains no provisions relating to the connection of individual lengths of pipe.

Note 2: The connection or joining method can influence the corrosion performance of the materials specified in this Standard.

Note 3: It is necessary to recognize that not all PSL-1 categories and grades can be made cracking resistant per ISO 15156-3 and are, therefore, not included in PSL-2.

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

Note 5: This is a revised version of this standard, which is issued as revision (1)-2018. Revision (0)-2015 of the said standard specification is withdrawn.

1.2 GENERAL DEFINITIONS

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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.

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MAY:

Is used where a provision is completely discretionary.

2. GENERAL

Part II of this Standard specification is written in the form of amendments and supplements ANSI/API Specification 5CRA. 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.

PART II**2. CONFORMANCE****2.2 Units of Measurement**

All paragraphs shall be deleted and replaced with the following:

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

3. NORMATIVE REFERENCES

Delete this clauses and replace with the following:

API (AMERICAN PETROLEUM INSTITUTE)

API TR 5C3/ISO TR 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)

ASTM A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products

ASTM A604/A604M, Standard Practice for Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets

ASTM A941, Terminology Relating to Steel, Stainless Steel, Related Alloys and Ferroalloys

ASTM E18, Standard Test Methods for Rockwell Hardness of Metallic Materials

ASTM E21, Standard Test Methods for Elevated Temperature Tension Tests of Metallic Materials

ASTM E23, Standard Test Methods for Notched Bar Impact Testing of Metallic Materials

ASTM E29, Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

ASTM E45, Standard Test Methods for Determining the Inclusion Content of Steel

ASTM E213, Standard Practice for Ultrasonic Examination of Metal Pipe and Tubing

ASTM E309, Standard Practice for Eddy-Current Examination of Steel Tubular Products Using Magnetic Saturation

ASTM E340, Standard Test Method for Macroetching Metals and Alloys

ASTM E381, Standard Method of Macroetch Testing Steel Bars, Billets, Blooms, and Forgings

ASTM E407, Standard Practice for Microetching Metals and Alloys

ASTM E562, Standard Test Method for Determining Volume Fraction by Systematic Manual Point Count

ASTM E570, Standard Practice for Flux Leakage Examination of Ferromagnetic Steel Tubular Products

ASTM E709, Standard Guide for Magnetic Particle Testing

ASTM B668-14, Standard Specification for UNS N08028 and N08029 Seamless Pipe and Tube

ASTM E165, Standard Practice for Liquid Penetrant Examination for General Industry

ASTM E1019, Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloy by Various Combustion and Fusion Techniques

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 G28, Standard Test Methods for Detecting Susceptibility to Intergranular Corrosion in Wrought, Nickel-Rich, Chromium-Bearing Alloys

ASTM G31, Standard Guide for Laboratory Immersion Corrosion Testing of Metals

ASTM G48, Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution

ASTM G78, Standard Guide for Crevice Corrosion Testing of Iron-Base and Nickel-Base Stainless Alloys in Seawater and Other Chloride-Containing Aqueous Environments

ASNT (AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING)

ASNT SNT-TC-1A, Recommended Practice: Personnel Qualification and Certification in Non-Destructive Testing

NACE MR0175/ISO 15156-3, Petroleum and natural gas industries — Materials for use in H₂S-containing environments in oil and gas production — Part 3: Cracking-resistant CRAs (corrosion resistant alloys) and other alloys

NACE TM0198, Slow Strain Rate Test Method for Screening Corrosion-Resistant Alloys for Stress Corrosion Cracking in Sour Oilfield Service

BSI (BRITISH STANDARDS INSTITUTION)

BS EN ISO 9712, Non-Destructive Testing-Qualification and Certification of NDT Personnel-General Principals

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)

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

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

ISO 377, Steel and steel products — Location and preparation of samples and test pieces for mechanical testing

ISO 404, Steel and steel products — General

ISO 525, Bonded abrasive products — General requirements

ISO 4885, Ferrous products — Heat treatments — Vocabulary

ISO 4948-1, Steels — Classification — Part 1: Classification of steels into unalloyed and alloy steels based on chemical composition

ISO 4948-2, Steels — Classification — Part 2: Classification of unalloyed and alloy steels according to main quality classes and main property or application characteristics

ISO 6508-1, Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)

ISO 6929, Steel products — Definitions and classification

ISO 8501-1:2007, Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings

ISO 10474, Steel and steel products — Inspection documents

ISO 11484, Steel products — Employer's qualification system of non-destructive testing (NDT) personnel

ISO 14284, Steel and iron — Sampling and preparation of samples for the determination of chemical composition

ISO 80000-1, Quantities and Units — General Principles

ISO 6892-1, Metallic Materials — Tensile Testing: Method of Test at Room Temperature

ISO 6892-2, Metallic Materials — Tensile Testing at Elevated Temperature

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

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

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

ISO 10893-8, Non-Destructive Testing of Steel Tubes. Automated Ultrasonic Testing of Seamless and Welded Steel Tubes for the Detection of Laminar Imperfections

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

ISO 10893-4, Non- Destructive Testing of Steel Tubes. Liquid Penetrant Inspection of Seamless and Welded Steel Tubes for the Detection of Surface Imperfections

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

ISO 7539-1, Corrosion of metals and alloys - Stress corrosion testing - Part 1: General guidance on testing procedures

ISO 7539-5, Corrosion of metals and alloys - Stress corrosion testing - Part 5: preparation and use of C-ring specimens

ISO 9712, Non-destructive testing – Qualification and Certification of NDT personnel

7. MATERIAL REQUIREMENTS

7.1 Chemical Composition

Add to end of clause the following:

For alloy UNS N08028 the minimum PRE No. shall be 36 in the Persian Gulf Area.

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 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. 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.”

Delete the last paragraph of this section.

7.8 Corrosion Properties

The existing paragraph shall be deleted and replaced 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.

7.12 Hydrostatic Test

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

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

The second sentence shall be deleted.

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:

$$\frac{OD_{max} - OD_{min}}{OD_{max} + OD_{min}} \leq 0.6\%$$

9. INSPECTION AND TESTING

9.3.2 Test Method

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

Carbon, sulfur, nitrogen, and oxygen shall be determined by chemical combustion method as ASTM E1019.

9.14 Hydrostatic Test

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

All products shall be washed in clean water with chloride ion content (mass fraction) of less than 50 mg/l after hydrostatic test.

9.16 Non-Destructive Examination

9.16.1 General

The third paragraph shall be deleted and 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.

9.16.2 NDE personnel

The existing clause shall be deleted and 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.

9.16.5 Untested ends

The existing paragraph shall be deleted and 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, the untested ends shall be cropped off.

9.16.13 Disposition of pipe containing defects

a) Grinding or machining:

The existing sub-clause (1, 2, 3) shall be deleted and 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 10893-4 or ASTM E165 or for group 1, magnetic-particle inspection according to ISO 10893-5 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.

9.16.14 Disposition of coupling stock containing defects

a) Grinding or machining:

The existing sub-clause (1, 2, 3) shall be deleted and 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 ISO10893-4 or ASTM E165 or for group 1, magnetic particle inspection according to ISO 10893-5 or ASTM E709,

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.

10. SURFACE TREATMENT

10.2 Groups 2, 3 and 4

- **Delete clause**

- "Final washing in clean water with chloride ion content (mass fraction) of less than 200 mg/l."

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

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, heat and Lot. Number with the number being maintained through all production processes tests, and inspections.

13.3 Test Certificates

The existing part shall be deleted and replaced with following (other parts remain unchanged):

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

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

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

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

TABLE A.3 — PSL-1 PRODUCT MECHANICAL PROPERTIES AT ROOM TEMPERATURE

The existing table shall be deleted and replaced with:

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

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 deleted and 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	3		4	5
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 ± 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 ± 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.

The existing table shall be deleted and replaced by:

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

Material identity from Table A.2		UNS number	Grade	Delivery condition	Yield strength ^f <i>R</i> _{p0.2} MPa		Tensile strength ^a <i>R</i> _m MPa	Elongation ^b <i>e</i> %	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	80	QT	552	655	621	b	27
			95	QT	655	724	724		27
2	22-5-3	S31803	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	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	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	80	SA	552	724	758	20	28
			90	SA	621	724	793	20	30
S39274	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-	110	CH	758	965	793	12	33
			125	CH	862	1 000	896	12	35
	25-32-3	N08535	110	CH	758	965	793	12	33
			125	CH	862	1 000	896	12	35
	22-35-4	N08135	110	CH	758	965	793	12	33
	4	21-42-3	N08825	110	CH	758	965	793	11
125				CH	862	1 000	896	10	35
22-50-7		N06985	110	CH	758	965	793	11	35
			125	CH	862	1 034	896	10	37
25-50-6		N06255	110	CH	758	965	793	11	35
			125	CH	862	1 034	896	10	37
N06975		110	CH	758	965	793	11	35	
		125	CH	862	1 034	896	10	37	
20-54-9		N06950	110	CH	758	965	793	11	35
			125	CH	862	1 034	896	10	37
15-60-16	N10276	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.

$$e = 1944 \frac{A^{0.2}}{R_m^{0.9}}$$

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.

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

The existing table shall be deleted and 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	0,03	11,5 to 13,5	4,5 to 6,5	bal.	0,5	0,5	1,5 to 3	—	—	0,02	0,005	0,01 to 0,5	—	0,5	—	—	—	NA	
2	Duplex austenitic/ferritic	22-5-3	S31803	0,03	21,0 to 23,0	4,5 to 6,5	bal.	2	1	2,50 to 3,50	—	—	0,03	0,02	—	—	—	—	0,08 to 0,20	—	35 to 40	
		25-7-3	S31260	0,03	24,0 to 26,0	5,5 to 7,5	bal.	1	0,75	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	
		25-7-4	S32750	0,03	24,0 to 26,0	6,0 to 8,0	bal.	1,2	0,8	3,0 to 4,0	—	—	—	0,035	0,02	—	—	—	—	0,24 to 0,32	—	40 to 45
3	Austenitic Fe base	27-31-4	N08028	0,03	26,0 to 28,0	6,0 to 8,0	bal.	1	1	3,0 to 4,0	—	0,5 to 1,0	0,03	0,01	—	—	—	0,5 to 1,0	0,2 to 0,3	—	40 to 45	
		25-32-3	N08535	0,030	24,0 to 27,0	29,0 to 36,5 g	bal.	1,00 to 1,4	0,50 to 4,0	—	g	1,50 to 4,0	0,03	0,03	—	—	—	—	—	—	—	NA
		22-35-4	N08135	0,03	20,5 to 23,5	33,0 to 38,0	bal.	1,0 to 0,75	4,0 to 5,0	—	—	0,70 to 0,8	0,03	0,03	—	—	—	—	0,2 to 0,8	—	—	NA

TABLE A.28 — (Continued)

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
		21-42-3	N08825	0,05	19,5 to 23,5	38,0 to 46,0	bal.	1,00	0,5	2,5 to 3,5	—	1,5 to 3,0	0,03	0,03	0,6 to 1,2	—	—	—	—	—	NA
		22-50-7	N06985	0,015	21,0 to 23,5	bal.	18,0 to 21,0	1,00	1,00	6,0 to 8,0	5,0	1,5 to 2,5	0,04	0,03	—	0,50	—	1,5	—	—	NA
		25-50-6	N06255	0,03	23,0 to 26,0	47,0 to 52,0	bal.	1,00	0,03	6,0 to 9,0	—	1,20	0,03	0,03	0,69	—	—	3,0	—	—	NA
4	Austenitic Ni base	25-50-6	N06975	0,03	23,0 to 26,0	47,0 to 52,0	bal.	1,00	1,00	5,0 to 7,0 ^h	—	0,70 to 1,20	0,03	0,03	0,7 to 1,50	—	—	h	—	—	NA
		20-54-9	N06950	0,015	19,0 to 21,0	50,0 min	15,0 to 20,0	1,00	1,00	8,0 to 10,0	2,5	0,5	0,04	0,015	—	0,50	0,04	1,0	—	—	NA
		15-60-16	N10276	0,02	14,5 to 16,5	bal. ⁱ	4,0 to 7,0	1,00	0,08	15,0 to 17,0	2,5 ⁱ	—	0,030	0,030	—	—	0,35	3,0 to 4,5	—	—	NA

a Designation of categories:
 — 1st digit: nominal chromium content;
 — 2nd digit: nominal nickel content;
 — 3rd digit: nominal molybdenum content.
 b PRE = % Cr + 3,3 (% Mo + 0,5 % W) + 16 % N.
 c Bal. is the balance of composition up to 100%, determined arithmetically by difference.
 g Ni + Co = 29,5 % minimum.
 h When specified, Mo+W=6% minimum.
 i Ni+Co= 52% minimum.
 j from BS EN 10088-3:2014, ASTM B668-14.

ANNEX C
(NORMATIVE)
TABLES IN USC UNITS

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

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

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

The existing table shall be deleted and 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

**ANNEX E
(NORMATIVE)
CLEANLINESS REQUIREMENTS**

The existing table shall be deleted and replaced by:

TABLE E.3 — MICROSCOPIC CLEANLINESS ACCEPTANCE LIMITS

Inclusions^a	Severity	
	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 micro -etched material either shall result in rejection, or shall be allowed a retest, or shall be brought to the attention of the purchaser for resolution.