CNOOC AND SHELL PETROCHEMICALS COMPLEX PROJECT - MANUAL

METALLIC MATERIALS - SELECTED STANDARDS

DEP 30.10.02.11-CSPC

June 2002

****** This DEP has been amended to be project specific and is based on DEP 30.10.02.11-Gen., dated November 1994 incorporating DEP Circular 35/98.

Revisions to the original DEP are highlighted by underlining new text and striking through deleted text ******

DESIGN AND ENGINEERING PRACTICE

PREFACE

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The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

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APPENDICES

1. INTRODUCTION

1.1 SCOPE

This DEP specifies appropriate standards for metallic construction materials. This DEP is applicable to goods fabricated both inside and outside China and has been customised to include materials supplied in accordance with standards of The People's Republic of China.

By identifying alternative materials standards, this DEP has two main functions, as follows:

- Where a particular materials standard is specified for certain equipment (e.g. in a DEP), if the Contractor wishes to propose an alternative (equivalent) material he may use this DEP to select a suitable materials standard which would normally be acceptable to the Principal. Note, however, that such substitution shall not be made automatically and still requires the approval of the Principal.
- In situations where required materials are not explicitly specified, this DEP may be invoked to act as a basis for the Contractor's materials selection.

It should be realized that materials may fail owing to undesirable properties being induced during fabrication and/or service, such as metallurgical changes or corrosion of various types. Such factors shall be taken into account when selecting a material for a given service. Measures which may be required to prevent or limit such risks (e.g. special heat treatment) are outside the scope of this DEP and are not indicated. **The materials engineer should therefore be consulted regarding selection of materials.**

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI and SIEP, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors nominated by them (i.e. the distribution code is "C", as described in DEP 00.00.05.05-CSPC).

This DEP is intended for use on the CSPC Project.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 STANDARDS

This DEP identifies materials to ASTM standards with reference to various other standards, including People's Republic of China Standards. In order to avoid confusion and to provide a consistent basis for the basic specification of the materials, **only one series of standards should be used** for any particular piece of equipment (i.e. avoid mixing ASTM standards with JIS standards, etc.).

Where a deviation from this rule is required, agreement shall be obtained from the Principal.

The use of trade names for materials shall be avoided whenever an authoritative specification reference is available.

NOTES: 1. Where metric versions of ASTM standards are available (e.g. ASTM A278M) they should be selected. In most cases, ASTM standards and their metric version are issued as a single standard (e.g. ASTM A182/A182M).

2. When BS, DIN or AFNOR standards are replaced by EN standards, the EN standard shall be considered equivalent.

1.4 CATEGORIES OF METALS

The following categories of metals are covered by this DEP:

- Ferrous metals - unalloyed
- Ferrous metals - alloyed
- Non-ferrous metals

In each category the following products are dealt with:

- Plates, sheets and strip;
- Tubes and tubing;
- Pipe;
- Forgings, flanges and fittings;
- Castings;
- Bars, sections and wire;
- Bolting.

1.5 SEQUENCE OF MATERIALS

The sequence of materials in the column "Designation and Application" in Sections 2, 3 and 4 is generally such that the subsequent number indicates a material with an increase in the concentration and/or number of the alloying elements.

1.6 SPECIFICATION OF MATERIALS

Materials standards identified on drawings, requisition sheets or other documents shall be specified fully in accordance with the information given in Sections 1.11, 2, 3 and 4, including all additional requirements applicable to the standard. For materials covered by the MESC system, the additional requirements stated therein shall also be met.

The latest issue of the selected materials standard shall be used. As this latest issue (including amendments) always prevails, the year of issue of the standard need not be shown.

1.7 METAL TEMPERATURE LIMITS

The temperature limits shown in Sections 2, 3 and 4 are approximate limits allowed for the average temperature through the cross-section of the construction material during normal operation.

The values mentioned should be regarded as an indication only and do not necessarily apply to cases where corrosion and/or conditions which may affect the structure of the material occur.

It should be noted that the indicated temperature limits do not necessarily exclude the application of the materials beyond these limits, especially for non-pressure-retaining parts such as internal parts of columns, baffles of heat exchangers, supporting structures, etc.

Temperatures shown in brackets, e.g. (+400), are unusual for the indicated application but are allowable from a materials point of view, if so required.

Special attention should be given to the specification and application of metals for service at low temperatures (metal temperature -20 °C or lower), for which reference shall be made to Appendix 1 of this specification and to DEP 30.10.02.31-CSPC. **The materials engineer should be consulted if there is any doubt on the choice of material for extreme service temperatures.**

1.8 CHEMICAL COMPOSITION

Chemical composition requirements relate to product analyses.

Percentage compositions are by mass.

1.9 DEFINITIONS

1.9.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.9.2 Specific definitions

bar Round, square, rectangular, oval, half-round and half-oval products, usually ordered in random lengths.

bolting Fastening element provided with thread.

(headed) bolt:
Fastening element with a head (usually hexagonal) at one end, the other end being threaded to take a nut.

stud bolt:
Fastening element, generally with continuous thread, to be used with nuts at both ends.

stud:
Fastening element with discontinuous thread, one end threaded to be screwed into a body, the other end threaded to take a nut.

nut:
Fastening element provided with female thread.

casting Product obtained by pouring molten metal into a mould.

flanges and fittings Standard piping components other than tube/pipe, valves, bolting and gaskets.

forging Metal product, hot worked or hot stamped into a desired shape.

pipe Tubular product; sizes up to and including DN 300 indicated by a nominal size roughly corresponding to the inside diameter; sizes larger than DN 300 indicated by the outside diameter. Pipe is usually ordered in random lengths.

plate Flat product, minimum thickness approximately 6 mm and minimum width approximately 300 mm.

section A shape that is long in relation to its cross-sectional dimensions, having a cross section other than those of wire, rod, bar, tube, tubing and pipe, such as L, U, I, T, etc.

sheet Flat product, thickness less than 6 mm and minimum width approximately 300 mm.

strip Flat product, maximum width approximately 300 mm and maximum thickness approximately $^1/_6$ of the width.

tube Tubular product, indicated by the outside diameter and usually ordered cut to a specific length.

tubing Tubular product of small diameter, indicated by the outside diameter and usually ordered in long lengths.

wire Round product, usually ordered in long lengths.

1.9.3 Abbreviations

AFNOR	Association Française de Normalisation
ASTM	American Society for Testing and Materials
BS	British Standard
DIN	Deutsches Institut für Normung
ISO	International Organization for Standardization
JIS	Japanese Industrial Standard

1.10 MATERIALS TABLES

In the tables in sections 2, 3 and 4 a new column has been added where there are equivalent Chinese materials standards.

For simplicity, the Chinese references have been abbreviated and the full material specification number can be found in GB 150 and GB 151. The designations shown in the tables are widely recognised in China.

For example, in section 2.2.2, carbon steel tube equivalent to ASTM A 179 is shown as "10" or "20". By referring to GB 150, the material specification is found to be GB 8163 for thicknesses not greater than 16 mm.

1.11 ADDITIONAL REQUIREMENTS FOR STEEL PLATE MANUFACTURED TO PEOPLES' REPUBLIC OF CHINA STANDARDS

1.11.1 **The Rolling Reduction Ratio** from cast slab to plate shall be **minimum of 3:1**.

1.11.2 Mechanical Testing

Tensile Test Specimen Orientation

The longitudinal axis of the normal tensile test specimen shall be transverse to the direction of the final plate rolling.

Charpy Impact Test Specimens Depth Location for Thicker Plates

For plate thickness, T: 30.0 mm < T ≤ 60.0 mm; Charpy Impact test specimens to be machined from 0.25 T depth.

For plate thickness, T: T > 60.0 mm; Charpy Impact test specimens to be machined from 0.50 T depth.

1.11.3 Chemical Analysis

The plate mill certificate shall state the composition of the heat by recording the contents of all of the nominated elements required by that specification. If measured, other trace element contents shall also be recorded on the plate mill certificate.

1.11.4 3rd Party Inspection

The steel plate manufacturer shall grant to nominated 3rd Party Inspectors free and reasonable access to all steel and plate mills production facilities, test houses and relevant testing and other quality control/quality assurance records.

1.11.5 Stainless Steel Plate Surface Finish Quality

Unless stated otherwise on the purchase order, the minimum standard surface finish quality for stainless steel plate shall be that which has been: Hot Rolled or Cold Rolled, and Annealed or Heat Treated, and Blast Cleaned or Pickled (equivalent to No. 1 Finish, ASTMA 480M).

2. FERROUS METALS - UNALLOYED

2.1 PLATES, SHEETS AND STRIP

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
2.1.1	Carbon steel sheets of structural quality, galvanized For general use	+100	A 446 - A/ G165	2989-Z22/ G600	17162-2: St E250-2Z Gruppe 600	-	-	-	4998: Z600-220	
2.1.2	Carbon steel plates of structural quality up to 50 mm thickness For non-pressure-retaining parts	(+350)	A 283 - C 1) C content 0.23% max.	EN10025: Fe 430B	EN 10025: Fe 430B	EN10025: Fe 430B	G 3106 SM 400 B or C 1)	Q235-A	630 - Fe 430B	1) To be killed or semi-killed.
2.1.3	Carbon steel plates of structural quality For standard vertical storage tanks with internal pressure up to 54 mbar (546 mm water column) and vacuum up to 6.2 mbar (64 mm water column) 1)	(+350)	A 283 - C 2) C content 0.23% max.	EN10025: Fe 430B	EN 10025: Fe 430B	EN10025: Fe 430B	G 3106 SM 400 B or C 2)	Q235-A Q235-B Q235-C	630 - Fe 430B	1) For further reference see DEP 34.51.01.31-CSPC. 2) To be killed or semi-killed.
2.1.4	Carbon steel plates (killed or semi-killed) up to 50 mm thickness - low strength For pressure-retaining parts	+400	A 285 - C 2) C content 0.23% max.	1501: 151 - 400B/430B 1)	17155: H II 2)	A 36-205 A 42 CP 2)	G 3103 SB 410 C content 0.23% max. Mn may be increased to 1.30% max. or G 3115 SPV 235	20R	2604-4 P7/P9	1) Replace suffix B with A if guaranteed elevated temper-ature properties are not required. 2) To be killed or semi-killed.
2.1.5	Carbon steel plates (Si-killed) - low/medium strength For pressure-retaining parts	+400	A 515 - 60/65 C content 0.23% max.	1501: 161 - 400B/430B 1)	17155: H II 2)	A 36-205 A 42 CP 2)	G 3103 SB 410 C content 0.23% max. Mn may be increased to 1.30% max. or G 3115 SPV 235	20R 16MnR	2604-4 P7/P9	1) Replace suffix B with A if guaranteed elevated temper-ature properties are not required. 2) To be Si-killed.
2.1.6	C-Mn steel plates (Si-killed) - medium/high strength For tube sheets not welded to shell and/or tubes	+400	A 515 -70 1)	1501: 223-490B or 1501: 224-490B 1) 2)	17155: 19 Mn 6	A 36-205 A 52 CP 3)	G 3103 SB 480 or G 3115 SPV 315	16MnR	2604-4 P16/P18	1) For tube sheets to be welded to tubes, see 2.1.7. For tube sheets to be welded to shell, see 2.4.3. 2) Replace suffix B with A if guaranteed elevated temper-ature properties are not required. 3) To be Si-killed.

2. FERROUS METALS - UNALLOYED (Cont'd)

2.1 PLATES, SHEETS AND STRIP (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
2.1.7	C-Mn steel plates (killed or semi-killed) - high strength For pressure-retaining parts and for tube sheets to be welded to tubes	+400	A 299 1) C content 0.23% max. Mn content 1.30% max.	1501: 223-490B or 1501: 224-490B 1) 2)	17155: 19 Mn 6	A 36-205 A 52 CP 3)	G 3115 SPV 355	16MnR	2604-4 P18	1) For tube sheets to be welded to shell, see 2.4.3. 2) Replace suffix B with A if guaranteed elevated temperature properties are not required. 3) To be killed or semi-killed.
2.1.8	Fine-grained C-Mn steels - low strength For pressure-retaining parts also at low temperatures	+400 1) 6)	A 516 - 55/60 C content 0.23% max. A 662 - A 4)	1501: 224-400 A/B or 430 A/B 2) 3) 4)	17102: T St E 285/ T St E 315 4) 5)	A 36-205 A 37/A 42 FP 4) 5)	G 3126-SLA 235B/ SLA-325A 4)	16MnR 16MnDR (low temp. minus 40ºC)	2604-4 P9	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) Use suffix A if guaranteed elevated temperature properties are not required. Use suffix B if guaranteed elevated temperature properties are required. 3) The suffix LT followed by a number shall be added if impact tests at or below 0 °C are required. (The number indicates the impact test temperature - see BS 1501) 4) For tube sheets to be welded to shell, see 2.4.3. 5) To be killed or semi-killed. 6) Specify V+Ti+Nb < 0.15%
2.1.9	Fine-grained C-Mn steels - medium strength For pressure-retaining parts also at low temperatures	+400 1) 6)	A 516 - 65 C content 0.23% max. A 662 - B 4)	1501: 224-460 A/B 2) 3) 4)	17102: T St E 355 4)	A 36-205 A 48 FP 4) 5)	-	16MnR 16MnDR (low temp. minus 40ºC)	2604-4 P15	
2.1.10	Fine-grained C-Mn steels - high strength For pressure-retaining parts also at low temperatures (Use subject to specific approval)	+400 1) 6)	A 537 - Class 1 (Normalized) 4)	1501: 224-490 A/B 2) 3) 4)	17102: T St E 380 4)	A 36-205 A 52 FP 4) 5)	-	16MnR	-	
2.1.11	Fine-grained C-Mn steels - very high strength For pressure-retaining parts (Use subject to specific approval.)	+400 6)	A 537 - Class 2 (Q/T)	-	17102: E St E 460	-	-	-	-	

2. FERROUS METALS - UNALLOYED (Cont'd)

2.2 TUBES AND TUBING

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
2.2.1	Electric-resistance-welded carbon steel tubes For unfired heat transfer equipment	+400	A 214 1) 4)	3606: ERW 320 1) 4)	17177: St 37.8 1)	A 49-142 TS E185A 1)	G 3461 STB 340 ERW 1)	10 20 1)	2604-3 TW5 1) 4)	1) A non-destructive electric test in accordance with the requirements of ASTM A450 or equivalent shall be carried out in addition to the hydrostatic test. 2) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 3) Electric-resistance-welded tube may be used up to and including 102 mm external diameter. 4) To be killed or semi-killed. 5) Specify elevated temperature properties.
2.2.2	Seamless cold-drawn carbon steel tubes For unfired heat transfer equipment	+400 2)	A 179 1) 4)	3606: CFS 320 1)	17175: St 35.8 III 1)	A 49-215 TU 37-C 1)	G 3461 STB 340 Seamless 1)	10 20	2604-2 TS5 1)	
2.2.3	Electric-resistance-welded carbon steel tubes For boilers and superheaters	+400	A 178 - A 1) 3) 4) 5)	3059: Part 1 - ERW 320 1) 3) 4) 5)	17177: St 37.8 1) 3) 5)	A 49-243 TS 37-C 1) 3) 5)	G 3461 STB 340 ERW 1) 3) 5)	20 1)	2604-3 TW5 1) 3) 4) 5)	
2.2.4	Electric-resistance-welded carbon steel tubes (Si-killed) For boilers and superheaters at high working pressures	+400	A 226 1) 3) 5)	3059: Part 2 - ERW-2 360 Cat. 2 1) 3) 5)	17177: St 37.8 1) 3) 5)	A 49-243 TS 37-C 1) 3) 5)	G 3461 STB 340 ERW 1) 3) 5)	20 1)	2604-3 TW5 1) 3) 4) 5)	
2.2.5	Seamless carbon steel tubes (Si-killed) For boilers and superheaters at high working pressures	+400	A 192 1) 5)	3059: Part 2 - S2 360 Cat. 2 1) 5)	17175: St 35.8 III 1) 5)	A 49-213 TU 37-C 1) 5)	G 3461 STB 340 Seamless 1) 5)	20G	2604-2 TS5 1) 5)	
2.2.6	Seamless carbon steel tubes (Si-killed) For unfired heat transfer equipment operating at low service temperatures	+400 2)	A 334-6 C content 0.23% max. 1)	3603: CFS 430 LT 1)	17173: TT St 35 N 1)	A 49-215 TU 42BT 1)	G 3464 STBL 380 C content 0.23% max. 1)	16Mn 09MnD	2604-2 TS10 1)	

2. FERROUS METALS - UNALLOYED (Cont'd)

2.3 PIPE

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
2.3.1	Galvanized seamless carbon steel pipe For air and water lines only	+50	- 1) 2)	-	2440 1)	-	-	-	65 1)	1) Galvanized pipe with screwed connections only. 2) Specify seamless API 5L-B pipe with NPT threaded couplings, galvanized to ASTM A53, para 19.
2.3.2	Electric-resistance-welded carbon steel pipe For outside plot product lines, except lines carrying hazardous products, including hydrocarbons lighter than gasoline	+350	- 1) 2)	3601: ERW 430 2)	1626 St 44.0	A 49-242 TS E290 2)	G 3454 STPG 410 2)	-	2604-3 TW9 2)	1) Specify API 5L-B electric-resistance welded pipe. C content 0.23% max. Mn may be increased to 1.30% max. 2) To be killed or semi-killed.
2.3.3	Electric-fusion-welded carbon steel pipe, sizes larger than DN 400 For inside plot product lines	+400	A 672 - C 65 Class 32 C content 0.23% max.	-	-	-	-	-	-	
2.3.4	Seamless carbon steel pipe For most inside plot product and utility lines. (For certain specific services, ASTM A106-B pipe to be used - see 2.3.6.)	+400	- 1) 2)	3601: S430 2)	-	A 49-211 TU E250B 2)	-	10 20	2604-2 TS 9 2)	1) Specify API 5L-B seamless pipe with C content 0.23% max. Mn may be increased to 1.30% max. Pipe shall be furnished in the normalized condition. 2) To be killed or semi-killed. Seamless usually not obtainable in sizes larger than DN 400. For larger sizes see 2.3.5.
2.3.5	Submerged arc welded carbon steel pipe, sizes larger than DN 400 For inside plot product and utility lines	+400	- 1) 2)	-	-	-	-	-	-	1) Specify API 5L -B submerged-arc welded pipe with C content 0.23% max. Mn may be increased to 1.30% max. Pipe shall be furnished in the normalized condition. 2) To be killed or semi-killed.

2. FERROUS METALS - UNALLOYED (Cont'd)

2.3 PIPE (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
2.3.6	Seamless C-Mn steel pipe (Si-killed) For inside plot piping, for special services (such as hydrocarbon + hydrogen, hydrocarbon + sulphur compounds, fuel gas). For seamless shells of vessels, for welded-on nozzles, for welded furnace coils and for certain special applications	+400	A 106 -B C content 0.23% max., Mn may be increased to 1.30% max. Normalized	3602: HFS 430 Cat. 2 Normalized	17175: St 45.8 I III Normalized	A 49-211 TU E250 Normalized 1) A 49-213 TU 42C Normalized	G 3455 STS 410 (350 C max.) C content 0.23% max. Normalized G 3456 STPT 410 C content 0.23% max. Normalized	20	2604-2 TS 5 or TS 9H Normalized	1) To be killed or semi-killed. Seamless usually not obtainable in sizes larger than DN 600. For larger sizes use ASTM A672 C65 Class 32 (see 2.3.3)
2.3.7	Seamless fine-grained C-Mn steel pipe (Si-killed) For process lines at low service temperatures	(+400) 1) 2)	A 333 - Grade 6 C content 0.23% max., Mn may be increased to 1.30% max.	3603: HFS 430LT	-	A 49-230 TU 42 BT	G 3460 STPL 380 C content 0.23% max.	16Mn	2604-2 TS 10	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31 -CSPC. 2) Specify V+Ti+Nb < 0.15% Seamless usually not obtainable in sizes larger than DN 400. For larger sizes use ASTM A671, CC65, Class 32 (see 2.3.8)
2.3.8	Electric-fusion-welded fine-grained C-Mn steel pipe (Si-killed), sizes larger than DN 400 For process lines at moderate or low service temperatures	(+400) 1) 2)	A 671 - CC65 Class 32 C content 0.23% max., Mn may be increased to 1.30% max.	-	-	-	-	-	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) Specify V+Ti+Nb < 0.15%

2. FERROUS METALS - UNALLOYED (Cont'd)

2.4 FORGINGS, FLANGES AND FITTINGS

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
2.4.1	Carbon steel butt-welding pipe fittings For general use	+400	A 234 - WPB or WPBW C content 0.23% max. Mn may be increased to 1.30% max. Normalized	1640: WPB C content 0.23% max. Mn may be increased to 1.30% max. Normalized	-	-	-	-	-	Sizes up to DN 400 incl. shall be seamless. Larger sizes may be either seamless or welded.
2.4.2	Carbon steel butt-welding pipe fittings For low service temperature	(+400) 1)	A 420 - WPL6 or WPL6W C content 0.23% max. Mn may be increased to 1.30% max. Normalized	1640: WPLO C content 0.23% max. Mn may be increased to 1.30% max. Normalized	-	-	-	-	-	Sizes up to DN 400 incl. shall be seamless. Larger sizes may be either seamless or welded. 1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
2.4.3	Carbon steel forgings For piping components, including flanges, fittings, valves and other pressure-retaining parts and also for tube sheets to be welded to shell	+400	A 105 C content 0.25% max., Mn may be increased to 1.20% max. Normalized	1503: 221-460 Normalized	17243: 17Mn4 Normalized	E 29-204 BF48N	G 3202 SFVC 2A. C content 0.25% max. Mn may be increased to 1.20% max. Normalized	-	2604-1 F 12 N	
2.4.4	Carbon steel forgings For pressure vessel components and associated pressure-retaining equipment, including tube sheets	+400	A 266 - Class 2 C content 0.25% max. Normalized	-	-	-	-	20 16Mn	-	-
2.4.5	Carbon-manganese steel forgings For piping components, including flanges, fittings, valves and other pressure-retaining parts at low service temperatures	(+400) 1)	A 350 - LF2 C content 0.23% max. Normalized	1503: 224-430LT40 Normalized	-	-	G 3205 SFL 2 C content 0.23% max. Normalized	16Mn 16MnD	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
2.4.6	Carbon-manganese steel forgings For pressure vessel components and associated presure-retaining equipment, including tube sheets, at low service temperatures	+350 1)	A765 - Grade II C content 0.23% max.	-	-	-	-	-	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.

2. FERROUS METALS - UNALLOYED (Cont'd)

2.5 CASTINGS

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
2.5.1	Grey iron castings For non-pressure-retaining (internal) parts	+350	A 48 Class 30 A 48 Class 40	1452: 220 1452: 300	1691: GG 25 1691: GG 30	A 32-101 FGL 250 F 32-101 FGL 300	G 5501 FC 250 G 5501 FC 300	-	185: 250 185: 300	1) Cast iron not to be used in hazardous service or above 10 bar. 2) Mechanical properties may be improved by the addition of certain elements, such as Cr and Ni (i.e. "pearlitic cast iron").
2.5.2	Grey iron castings For non-pressure-retaining (internal) parts at elevated temperatures	+650	A 319 -Class II	-	-	-	-	-	-	
2.5.3	Grey iron castings For pressure-retaining parts and cooler channels	+350	A 278 Class 40 1) 2)	1452: 300 1) 2)	1691: GG 30 1) 2)	A 32-101 FGL 300 1) 2)	G 5501 FC 300 1) 2)	-	185: 300	
2.5.4	Ductile iron castings For pressure-retaining parts including fittings and valves	+400	A 395 1)	2789: 400/18 2)	1693: GGG 40	A 32-201 FGS 400/18 2)	G 5502 FCD 400	-	1083: 400/18 2)	1) Metallographic examination in accordance with ASTM A395 shall be made additionally to the tensile test. 2) Hardness test and 0.2% proof test to be included in test-ing programme.
2.5.5	Steel castings For pressure-retaining parts	(+400)	A 216 - WCA WCB* WCC * C content 0.25% max.	1504: 161-430A 161-480A* 161-480A* * C content 0.25% max.	17245: GS-C25	A 32-055 A 420 CP-M A 480 CP-M	G 5151 SCPH1 SCPH2* * C content 0.25% max. Mn may be increased to 1.20% max.	-	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
2.5.6	Steel castings For pressure-retaining parts at low service temperatures	(+400) 1)	A 352 - LCB* LCC * C content 0.25% max.	1504: 161- 430ALT40	SEW 685 GS-21Mn5	A 32-055 A 420 FP-M A 480 FP-M	G 5152 SCPL1* * C content 0.25% max. Mn may be increased to 1.20% max.	-	-	

2. FERROUS METALS - UNALLOYED (Cont'd)

2.6 BARS, SECTIONS AND WIRE

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
2.6.1	Carbon steel bars, sections and raised-tread plates of structural quality For general structural purpose	+350	A 36 C content 0.23% max. 1) 2)	EN 10 025: Fe 430B	EN 10 025: Fe 430B	EN 10 025: Fe 430B	G 3106 SM 400B or C 2)	Q235-A	630 Fe 430B	1) For non-welded items, and for items that will not be welded, restriction on C content may be disregarded. 2) To be killed or semi-killed.
2.6.2	Low-carbon steel bars For machined parts	+400	A 576 - 1022 1) 2)	970: 080 A20 1)	17200: Ck 22	A 35-552 XC 18	G 4051 S22C	20Mn	-	1) To be killed or semi-killed. 2) Where free-machining quality is required specify Grade 1117.
2.6.3	Medium-carbon steel bars For machined parts	+400	A 576 - 1035 1045 1055 1) 2)	970: 080 A35 080 A47 080 A57 1)	17200: Ck 35 Ck 45 Ck 55	A 35-552 XC 38 H1 XC 48 H1 XC 55 H1	G 4051 S35C S45C S55C	35 45 55	683-1 C35 C45 C55	1) To be killed or semi-killed. 2) Where free-machining quality is required specify Grade 1137.
2.6.4	High-carbon steel bars For springs	+230	A 689/A 576 1095 1)	970: 060 A96 1)	-	-	-	-	-	1) To be killed or semi-killed.
2.6.5	Music spring quality steel wire For springs	+230	A 228	5216	-	-	-	-	-	
2.6.6	Carbon steel bars and sections For lifting lugs, sliding bars etc.	(+230)	A 36 C content 0.23% max. 1) 2)	EN 10 025: Fe 430B	EN 10 025: Fe 430B	A 35-501 E 28-2 2)	G 3106 SM 400B or C 2)	Q235-A	630 Fe 430B	1) For non-welded items, and for items that will not be welded, restriction on C content may be disregarded. 2) To be killed or semi-killed.

2.7 BOLTING

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
2.7.1	Carbon steel bolts For structural purposes	+230	A 307 - B	1769	-	-	-	Q235-A 35	-	Approved free machining quality acceptable. For bolting to be used beyond limits indicated see 3.7.1. For nuts see 2.7.2.
2.7.2	Carbon steel nuts For bolts specified under 2.7.1	+230	A 563 - A	1769	-	-	G 4051 S 43C	Q235-A 20 25	-	
2.7.3	Medium-carbon steel nuts For bolting specified under 3.7.1	+450	A 194 - 2H	4882: 2H	17200: C45	A 35-557 XC 38	-	35 40Mn	-	

3. FERROUS METALS - ALLOYED

3.1 PLATES, SHEETS AND STRIP

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.1.1	0.3 Mo steel plates For pressure-retaining parts at high service temperatures	+500	-	1501: 243 1)	17155: 15 Mo 3 1)	A 36-206 15 D 3 1)	-	-	2604-4 P26	**NOT** for hydrogen service. 1) Specify total Al content 0.012% max.
3.1.2	0.5 Mo steel plates For pressure-retaining parts at high service temperatures	+500	A 204 - A or B	-	-	-	G 3103 SB 450M or SB 480M C content 0.20% max. 1)	-	2604-4 P28	
3.1.3	Low-alloy nickel-copper-molybdenum-niobium steel plates For boiler drums	+500	-	-	-	-	-	-	-	Ordered against proprietary specifications subject to agreement.
3.1.4	Low-alloy manganese-chromium-molybdenum-vanadium steel plates For boiler drums	(+500)	-	1501: 271	-	-	-	-	-	
3.1.5	1 Cr - 0.5 Mo steel plates For high service temperatures and/or resistance to hydrogen attack 1)	+600	A 387 - 12 Class 2 2) 3)	1501: 620 2) 3)	17155: 13CrMo4 4 2) 3) 4)	A 36-206 15 CD 4-05 2) 3) 5)	G 4109 SCMV2 2) 3)	15CrMoR 3)	2604-4 P32 2) 3) 5)	1) For resistance to hydrogen attack, see API 941. 2) To be normalized and tempered or quenched and tempered. 3) Specify: Cu 0.20% max. Ni 0.30% max. (%Si+%Mn) ≤ 1.10 (%Si+%Mn) x (%P+%Sn) x 10^4 ≤ 150. 4) When resistance to hydrogen attack is required, specify Cr 0.8% min. 5) Specify Mo 0.45% min. for hydrogen service.

3. FERROUS METALS - ALLOYED (Cont'd)

3.1 PLATES, SHEETS AND STRIP (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.1.6	1.25 Cr - 0.5 Mo steel plates For high service temperatures and/or resistance to hydrogen attack 1)	+600	A 387 - 11 Class 2 2) 3) 4)	1501: 621 2) 3) 4)	-	-	G 4109 SCMV3 2) 3) 4)	-	-	1) For resistance to hydrogen attack, see API 941. 2) Specify to be normalized and tempered or quenched and tempered.
3.1.7	2.25 Cr - 1 Mo steel plates For high service temperatures and/or resistance to hydrogen attack 1)	+625	A 387 - 22 Class 2 2) 3)	1501: 622-515 2) 3)	17155: 10CrMo9 10 2) 3)	A 36-206 10 CD 9-10 2) 3)	G 4109 SCMV4 2) 3)	-	2604-4 P34 2) 3)	3) Specify: Cu 0.20% max. Ni 0.30% max. (%Si+%Mn) ≤ 1.10 (%Si+%Mn) x (%P+%Sn) x 10^4 ≤ 150. 4) Specify P 0.005% max.
3.1.8	3 Cr - 1 Mo steel plates For high service temperatures requiring optimum creep resistance and/or resistance to hydrogen attack 1)	+625	A 387 - 21 Class 2 2) 3)	-	-	A 36-206 10 CD 12-10 2) 3)	G 4109 SCMV5 2) 3)	-	-	
3.1.9	5 Cr - 0.5 Mo steel plates For high service temperatures and/or resistance to sulphur corrosion	+650	A 387 - 5 Class 2 1)	-	-	A 36-206 Z 10 CD 5-05 1)	G 4109 SCMV6 1)	-	-	1) Specify to be normalized and tempered or quenched and tempered.
3.1.10	0.5 Ni steel plates For pressure-retaining parts at low service temperatures	(+400) 1)	-	-	17280: 13 Mn Ni 6 3	A 36-208 0.5 Ni 355	-	-	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
3.1.11	1.5 Ni steel plates For pressure-retaining parts at low service temperatures	(+400) 1)	-	-	17280: 14 Ni Mn 6	A 36-208 1.5 Ni 355	-	-	2604-4 P42	
3.1.12	3.5 Ni steel plates For pressure-retaining parts at low service temperatures	(+400) 1)	A 203 - D	1501: 503	17280: 10 Ni 14	A 36-208 3.5 Ni 285	G 3127 SL3N255	-	2604-4 P43	
3.1.13	5 Ni steel plates For pressure-retaining parts at low service temperatures	(+400) 1)	-	-	17280: 12 Ni 19	A 36-208 5 Ni 390	G 3127 SL5N590	-	-	
3.1.14	9 Ni steel plates For pressure-retaining parts at low service temperatures	-200 1)	A 353 2)	1501: 510N 2)	17280: X 8 Ni 9 NNA 2)	A 36-208 9 Ni 490 2)	G 3127 SL9N520 2)	-	2604-4 P45 (N+N+T) 2)	1) For low temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) Specify C 0.10% max. Si 0.30% max. P 0.002% max. S 0.005% max.
			A 553 - Type I 2)	1501: 510 2)	17280: X 8 Ni 9 HA 2)	A 36-208 9 Ni 585 2)	G 3127 SL9N590 2)	-	2604-4 P45 (Q+T) 2)	

3. FERROUS METALS - ALLOYED (Cont'd)

3.1 PLATES, SHEETS AND STRIP (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.1.15	13 Cr steel plates, sheets and strip For pressure-retaining parts under certain corrosive conditions	+540	A 240 - Type 410S 1) A 240 - Type 405 1) 2)	- -	17440: X 6 Cr 13 1) 17440: X 6 CrAl 13 1) 2)	- -	- G 4304 SUS 405 1) 2)	0Cr13 1) 2) 0Cr13Al 1) 2) 3)	- -	1) For cladding purposes only. 2) Type 405 shall not be used above 400 °C. 3) Maximum 250 °C
3.1.16	18 Cr-8 Ni steel plates, sheets and strip For pressure-retaining parts at low service temperatures or to prevent product contamination	-200 (+400) 1)	A 240 - Type 304 2) A 240 - Type 304N 2)	1501 304S31 2) -	17440: X 5 CrNi 18 10 2) -	A 36-209 Z 7 CN 18-09 2) A 36-209 Z 6 CN 18-09 Az 2)	G 4304 SUS 304 2) G 4304 SUS 304N1 2)	0Cr18Ni9 2)	2604-4 P47 2) -	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
3.1.17	18 Cr-8 Ni steel plates, sheets and strip For pressure-retaining parts under certain corrosive conditions and/or low and moderate service temperatures	-200 +500 1)	A 240 - Type 304L 2)	1501: 304S11 2)	17440: X 2 CrNi 19 11 2)	A 36-209 Z 3 CN 18-10 2)	G 4304 SUS 304L 2)	00Cr19Ni10 2)	2604-4 P46 2)	2) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334.
3.1.18	18 Cr-8 Ni stabilized steel plates, sheets and strip For pressure-retaining parts under certain corrosive conditions and/or high service temperatures	(-100) +600	A 240 - Type 321 2) 3) A 240 - Type 347 2) 3)	1501: 321S31 2) 3) 1501: 347S31 2) 3)	17440: X 6 CrNiTi 18 10 2) 3) 17440: X 6 CrNiNb 18 10 2) 3)	A 36-209 Z 6 CNT 18-10 2) 3) A 36-209 Z 6 CNNb 18-10 2) 3)	G 4304 SUS 321 2) 3) G 4304 SUS 347 2) 3)	0Cr18Ni10Ti 2) 3)	2604-4 P53 2) 3) 2604-4 P50 2) 3)	3) For optimum resistance to intergranular corrosion, specify a stabilization heat treatment at 950 °C, subse-quent to solution heat treatment.
3.1.19	18 Cr-10 Ni-2 Mo steel plates, sheets and strip For pressure-retaining parts under certain corrosive conditions and/or high service temperatures	-200 +500 1)	A 240 - Type 316 2) A 240 - Type 316L	1501: 316S31 2) 1501: 316S11	17440: X 5 CrNiMo 17 12 2 2) 17440: X 2 CrNiMo	A 36-209 Z 7 CND 17-11-02 2) A 36-209 Z 3 CND 17-11-	G 4304 SUS 316 2) G 4304 SUS 316L	0Cr17Ni12-Mo2 2) 00Cr17Ni14-	2604-4 P60 2) 2604-4 P57	

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	**GB (CHINA)**	ISO	REMARKS
			2)	2)	17 13 2 2)	02 2)	2)	Mo2 2)	2)	

3. FERROUS METALS - ALLOYED (Cont'd)

3.1 PLATES, SHEETS AND STRIP (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.1.20	18 Cr-10 Ni-2 Mo stabilized steel plates, sheets and strip For pressure-retaining parts under certain corrosive conditions and/or high service temperatures	(-200) +500	A 240 - Type 316Ti 1) 2) A 240 - Type 316Cb 1) 2)	1501: 320S31 1) 2) -	17440: X 6 CrNiMoTi 17 12 2 1) 2) 17440: X 6 CrNiMoNb 17 12 2 1) 2)	A 36-209 Z 6 CNDT 17-12 1) 2) A 36-209 Z 6 CNDNb 18-12 1) 2)	- -	0Cr18Ni12-Mo2Ti 1) 2) -	- -	1) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334. 2) For optimum resistance to intergranular corrosion, specify a stabilization heat treatment at 950 °C, subsequent to solution heat treatment.
3.1.21	18 Cr-10 Ni-3 Mo steel plates, sheets and strip For pressure-retaining parts under certain corrosive conditions and/or high service temperatures	(-200) +500	A 240 - Type 317 1) A 240 - Type 317L 1)	- -	- 17440: X 2 CrNiMo 18 16 4 1)	- A 36-209 Z 3 CND 19-15-04 1)	G 4304 SUS 317 1) G 4304 SUS 317L 1)	0Cr19Ni13-Mo3 1) 00Cr19Ni13-Mo3 1)	- -	
3.1.22	25 Cr-20 Ni steel plates, sheets and strip For pressure-retaining parts under certain corrosive conditions and/or extreme service temperatures	+1000	A 240 - Type 310S	1501: 310S16	-	-	G 4304 SUS 310S		-	
3.1.23	18 Cr-8 Ni steel plates, sheets and strip For pressure-retaining parts at extreme service temperatures under certain corrosive conditions	+700	A 240 - Type 304H 1)	1501: 304S51 1)	-	A 36-209 Z 6 CN 18-09 1)		-	2604-4 P48 1)	1) Specify C 0.06% max. and Mo+Ti+Nb 0.4% max.

3. FERROUS METALS - ALLOYED (Cont'd)

3.1 PLATES, SHEETS AND STRIP (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	**GB (CHINA)**	ISO	REMARKS
3.1.24	22 Cr-5 Ni-Mo-N steel plates, sheets and strip For pressure-retaining parts under certain corrosive conditions	(-30) +300 1)	A 240 - S31803 2)	1501: 318S13 2)	SEW 400: X 2 CrNiMo N 22 5 3 2)	A 36-209 Z 3 CND 22-05 Az 2)	G 4304 SUS 329J 2L 2)	-	-	1) For low temperature applications, etc. 2) N 0.15% min.
3.1.25	25 Cr-7 Ni-Mo-N steel plates, sheets and strip For pressure-retaining parts under certain corrosive conditions	(-30) +300 1)	A 240 - S32750	-	-	A 36-209 Z 3 CND 25-07 Az		-	-	
3.1.26	20 Cr-18 Ni-6 Mo-Cu-N steel plates, sheets and strip For pressure-retaining parts under certain corrosive conditions	(-200) (+400) 1)	A 240 - S31254	-	-	-		-	-	
3.1.27	Carbon steel or low-alloy steel plates with ferritic stainless steel cladding For high service temperatures and/or certain corrosive conditions		A 263 1)	-	-	A 36-250 1)	-	GB8165 JB4733 1)	-	1) Specify base metal and cladding.
3.1.28	Carbon steel or low-alloy steel plates with austenitic stainless steel cladding For high service temperatures and/or certain corrosive conditions		A 264 1)	-	-	A 36-250 1)	-	GB8165 JB4733 1)	-	

3. FERROUS METALS - ALLOYED (CONT'd)

3.2 TUBES AND TUBING

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.2.1	Seamless 0.3 Mo steel tubes For boilers, super-heaters and unfired heat transfer equipment at high service temperatures	+500	-	3059: Part 2 - S2 243 1) 3606: CFS 243 1)	17175: 15 Mo 3 1)	A 49-213 TU 15 D 3 1)	-	-	2604-2 TS 26 1)	**NOT** for hydrogen service. 1) Specify total Al content 0.012% max.
3.2.2	Seamless 0.5 Mo steel tubes For boilers, super-heaters and unfired heat transfer equipment at high service temperatures	+500	A 209 - T1 1)	-	-	-	G 3462 STBA 12 Seamless 1)	20MoG 1)	-	
3.2.3	Seamless 1 Cr-0.5 Mo steel tubes For boilers, superheaters and unfired heat transfer equipment at high service temperatures and/or requiring resistance to hydrogen attack 1)	+600	A 213 - T12 3) 4)	3059: Part 2 - S2 620-460 3) 4) 3606: CFS 620 3) 4)	17175: 13 CrMo 4 4 2) 3) 4)	A 49-213 TU 13 CD 4-04 2) 3) 4)	G 3462 STBA 22 Seamless 3) 4)	15CrMo 4)	2604-2 TS 32 3) 4)	1) For resistance to hydrogen attack, see API 941. 2) When resistance to hydrogen attack is required specify Cr content 0.8% min., see API 941.
3.2.4	Seamless 1.25 Cr-0.5 Mo steel tubes For boilers, superheaters and unfired heat transfer equipment at high service temperatures and/or requiring resistance to hydrogen attack 1)	+600	A 213 - T11 3) 4) 5)	- 3606: CFS 621 3) 4) 5)	-	A 49-213 TU 10 CD 5-05 3) 4) 5)	G 3462 STBA 23 3) 4) 5)	-	-	3) Specify to be normalized and tempered or quenched and tempered. 4) Specify: Cu 0.20% max. Ni 0.30% max. (%Si+%Mn) ≤ 1.10 (%Si+%Mn) x (%P+%Sn) x 10^4 ≤ 150. 5) Specify P 0.005% max.

3. FERROUS METALS - ALLOYED (Cont'd)

3.2 TUBES AND TUBING (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.2.5	Seamless 2.25 Cr-1 Mo steel tubes For boilers, furnaces, super-heaters and unfired heat transfer equipment at high service temperatures requiring optimum creep resistance and/or resistance to hydrogen attack 1)	+625	A 213 - T22 2) 3)	3059: Part 2 - S2 622-490 2) 3) 3606: CFS 622 2) 3)	17175: 10 CrMo 9 10 2) 3)	A 49-213 TU 10 CD 9-10 2) 3)	G 3462 STBA 24 2) 3)	12Cr2Mo 3)	2604-2 TS 34 2) 3)	1) For resistance to hydrogen attack, see API 941. 2) Specify to be normalized and tempered or quenched and tempered.
3.2.6	Seamless 5 Cr-0.5 Mo steel tubes For high service temperatures and/or resistance to sulphur corrosion, eg. furnace tubes	+650	A 213 - T5 2)	3606: CFS 625 2)	-	A 49-213 TUZ 12 CD 05-05 2)	G 3462 STBA 25 2)	-	2604-2 TS 37 2)	3) Specify: Cu 0.20% max. Ni 0.30% max. (%Si+%Mn) ≤ 1.10 (%Si+%Mn) x (%P+%Sn) x 10^4 ≤ 150.
3.2.7	Seamless 9 Cr-1 Mo steel tubes For high service temperatures and/or resistance to sulphur corrosion, eg. furnace tubes	+650	A 213 - T9 2)	3059: S2 629-470 2)	-	A 49-213 TUZ 10 CD 09 2)	G 3462 STBA 26 2)	-	2604-2 TS 38 2)	
3.2.8	Seamless 3.5 Ni steel tubes For low service temperatures	(+400) 1)	-	3603: CFS 503 LT Cat. 2	17173: 10 Ni 14	A 49-230 TU 10 N 14	G 3464 STBL 450	-	2604-2 TS 43	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
3.2.9	Seamless 9 Ni steel tubes	-200 1)	-	3603: CFS 509 LT Cat. 2	17173: X 8 Ni 9	A 49-230 TUZ 6 N 9	G 3464 STBL 690	-	2604-2 TS 45	
3.2.10	Seamless 12 Cr steel tubes For unfired heat transfer equipment under certain corrosive conditions	+540	A 268 - TP 405 1) or A 268 - TP 410S 2)	- -	17456: X 6 Cr Al 13 1) -	- -	G 3463 SUS 405 TB 1) -	- 0Cr13 3)	- -	1) TP 405 not to be used above 400 °C. 2) Composition in accordance with ASTM A240 Type 410S. All requirements of A268 shall be fulfilled. 3) Maximum 500 °C.

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	**GB (CHINA)**	ISO	REMARKS
3.2.11	Seamless and welded 18 Cr-10 N-2Mo steel tubes For certain general applications	(-200) +500	A 269 - TP 316 1) or A 269 - TP 316L 1)	- -	- -	- -	- -	0Cr17Ni12-Mo2 2) 00Cr17Ni14-Mo22)	- -	1) For tubes intended for use with compression fittings, hardness shall not exceed 90 HRB 2) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334.

3. FERROUS METALS - ALLOYED (Cont'd)

3.2 TUBES AND TUBING (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.2.12	Welded 18 Cr-8 Ni steel tubes For superheaters and unfired heat transfer equipment to prevent product contamination or for low service temperatures	-200 (+400) 1)	A 249 - TP 304 2) 3)	3605: LWHT 304S31 2) 3) or 3606: LWHT 304S31 2) 3)	17457: X 5 CrNi 18 10 2) 3)	-	G 3463 SUS 304 TB 2) 3) 4)	0Cr18Ni9 3)	2604 - 5 TW 47 - LWHT 2) 3)	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) The tubes are welded without the addition of filler metal, so the inside diameter and the wall thickness of the tubes are restricted to DN100 max. and 5.5 mm max., respectively. A non-destructive electric test in accordance with ASTM A450 shall be carried out in addition to the hydrostatic test.
			A 249 - TP 304L 2) 3)	3605: LWHT 304S11 2) 3) or 3606 LWHT 304S11 2) 3)	17457: X 2 CrNi 19 11 2) 3)	-	G 3463 SUS 304 LTB 2) 3) 4)	00Cr19Ni10 3)	2604-5 TW46-LWHT 2) 3)	
3.2.13	Welded 18 Cr-8 Ni stabilized steel tubes For superheaters and unfired heat transfer equipment under certain corrosive conditions	(-100) +600	A 249 - TP 321 2) 3)	3605: LWHT 321S31 2) 3) or 3606 LWHT 321S31 2) 3)	17457: X 6 CrNiTi 18 10 2) 3)	- -	G 3463 SUS 321 TB 2) 3) 4)	0Cr18Ni10Ti 3) 5)	2604-5 TW53-LWHT 2) 3)	3) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334.
			A 249 - TP 347 2) 3)	3605: LWHT 347S31 2) 3) or 3606 LWHT 347S31 2) 3)	17457: X 6 CrNiNb 18 10 2) 3)		G 3463 SUS 347 TB 2) 3) 4)	0Cr18Ni11Nb 3) 5)	2604-5 TW50-LWHT 2) 3)	

3. FERROUS METALS - ALLOYED (Cont'd)

3.2 TUBES AND TUBING (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.2.14	Welded 18 Cr-10 Ni-2 Mo steel tubes For superheaters and unfired heat transfer equipment under certain corrosive conditions	-200 +500 1)	A 249 - TP 316 2) 3)	3605: LWHT 316S31 2) 3) or 3606 LWHT 316S31 2) 3)	17457: X 5 CrNiMo 17 12 2 2) 3)	-	G 3463 SUS 316 TB 2) 3) 4)	0Cr17Ni12- Mo2 3)	2604-5 TW60-LWHT 2) 3)	4) Specify automatic arc welded. 5) For optimum resistance to intergranular corrosion, specify a stabilization heat treatment at 950 °C subsequent to solution heat treatment..
			A 249 - TP 316L 2) 3)	3605: LWHT 316S11 2) 3) or 3606 LWHT 316S11 2) 3)	17457: X 2 CrNiMo 17 13 2 2) 3)	-	G 3463 SUS 316L TB 2) 3) 4)	00Cr17Ni14- Mo2 3)	2604-5 TW57-LWHT 2) 3)	
3.2.15	Welded 20 Cr-18 Ni-6 Mo Cu-N steel tubes For superheaters and unfired heat transfer equipment under certain corrosive conditions	(-200) (+400)	A 249 - S 31254 2)	-	-	-	-	-	-	
3.2.16	Seamless 18 Cr-8 Ni steel tubes For unfired heat transfer equipment to prevent product contamination or for low service temperatures	-200 +400 1)	A 213 - TP 304 2)	3606: CFS 304S31 2)	17458: X 5 CrNi 18 10 2)	A 49-217 TUZ 6 CN 18 09 2)	G 3463 SUS 304 TB Seamless 2)	0Cr18Ni9 2)	2604-2 TS47 2)	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
			A 213 - TP 304L 2)	3606: CFS 304S11 2)	17458: X 2 CrNi 19 11 2)	A 49-217 TUZ 2 CN 18 10 2)	G 3463 SUS 304L TB Seamless 2)	00Cr19Ni10 2)	2604-2 TS 46 2)	

3. FERROUS METALS - ALLOYED (Cont'd)

3.2 TUBES AND TUBING (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.2.17	Seamless 18 Cr-8 Ni stabilized steel tubes For superheaters and unfired heat transfer equipment under certain corrosive conditions and/or at high service temperatures	(-100) +600	A 213 - TP 321 2)	-	17458: X 6 CrNiTi 18 10 2)	A 49-214 Z 6 CNT 18 - 12B 2)	G 3463 SUS 321 TB Seamless 2)	0Cr18Ni10Ti 2) 3)	2604-2 TS 53 2)	2) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334. 3) For optimum resistance to intergranular corrosion, specify a stabilization heat treatment at 950 °C subsequent to solution heat treatment..
				3606: CFS 321S31 2)	-	A 49-217 TUZ 6 CNT 18 10 2)				
			A 213 - TP 347 2)	-	17458: X 6 CrNiNb 18 10 2)	A 49 -214 Z 6 CNNb 18 - 12B 2)	G 3463 SUS 347 TB Seamless 2)	0Cr18Ni11Nb 2) 3)	2604-2 TS 50 2)	
				3606: CFS 347S31 2)	-	-				
3.2.18	Seamless 18 Cr-8 Ni steel tubes For boilers, superheaters and unfired heat transfer equipment at extreme service temperatures under certain corrosive conditions	+815	A 213 - TP 304H 1)	3059: Part 2 - CFS 304S51 1)	-	A 49-214 Z 6 CN 19-10 1)	G 3463 SUS 304 HTB Seamless 1)	-	2604-2 TS 48 1)	1) Specify C 0.06% max. and Mo+Ti+Nb 0.4% max. 2) The use of this grade is subject to agreement of the Principal.
3.2.19	Seamless 18 Cr-8 Ni stabilized steel tubes For boilers, superheaters and unfired heat transfer equipment at extreme service temperatures under certain corrosive conditions	+815	A 213 - TP 321H 2)	3059: Part 2 - CFS 321S51 2)	-	-	G 3463 SUS 321 HTB Seamless 2)	-	2604-2 TS 54 2)	
			A 213 - TP 347H 2)	3059: Part 2 - CFS 347S51 2)	-	-	G 3463 SUS 347 HTB Seamless 2)	-	2604-2 TS 56 2)	

3. FERROUS METALS - ALLOYED (Cont'd)

3.2 TUBES AND TUBING (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.2.20	Seamless 18 Cr-10 Ni-2 Mo steel tubes For superheaters and unfired heat transfer equipment under certain corrosive conditions and/or at high service temperatures	-200 +500 1)	A 213 - TP 316 2) 3)	- 3606: CFS 316S31 2) 3)	17458: X 5 CrNiMo 17 12 2 2) 3)	A 49-214 Z 6 CND 17-12B 2) 3) A 49-217 TUZ 6 CND 17 11 3)	G 3463 SUS 316 TB Seamless 2) 3)	0Cr17Ni12-Mo2 3)	2604-2 TS60 2) 3)	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) May be used only for welded items with wall thicknesses less than 10 mm and for non-welded items. 3) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334.
			A 213 - TP 316L 3)	- 3606: CFS 316S11 3)	17458: X 2 CrNiMo 17 13 2 3)	- A 49-217 TUZ 2 CND 17 12 3)	G 3463 SUS 316 LTB Seamless 3)	00Cr17Ni14-Mo2 3)	2604-2 TS57 3)	
3.2.21	Seamless 18 Cr-8 Ni steel tubes For furnaces under certain corrosive conditions	+815	A 271 - TP 321H 1)	-	-	-	G 3467 SUS 321 HTF 1)	-	-	1) Wall thickness max. 25 mm.
			A 271 - TP 347H 1)	-	-	-	G 3467 SUS 347 HTF 1)	-	-	
3.2.22	Seamless 22 Cr-5 Ni-Mo-N steel tubes For certain corrosive conditions	+300	A 789 - S31803 1) 2)	-	-	A 49-217 TUZ2 CND 22 05 03 2)	G 3463 SUS 329 J2 LTB 2)	-	-	1) Specify seamless. 2) N 0.15% min. 3) Mo 3.0% min. 4) N 0.24% min.
3.2.23	Seamless 25 Cr-7 Ni-Mo-N steel tubes For certain corrosive conditions	+300	A 789 - S32750 1)	-	-	A 49-217 TUZ2 CND 25 07 03 3) 4)	-	-	-	
3.2.24	Seamless 20 Cr-18 Ni-6 Mo-Cu-N steel tubes For certain corrosive conditions	(-200) (+400)	A 269 - S31254 1)	-	-	A 49-217 TUZ1 CNDU 20 181 6 Az	-	-	-	

3. FERROUS METALS - ALLOYED (Cont'd)

3.3 PIPE

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.3.1	Electric-fusion-welded 0.5 Mo steel pipe, sizes larger than DN400 For high service temperatures	+500	A 672 - L65 Class 32 1)	-	-	-	-	-	-	**NOT** for hydrogen service 1) Specify total Al content 0.012% max.
3.3.2	Electric-fusion-welded 1 Cr-0.5 Mo steel pipe in sizes DN400 and larger For high service temperatures, requiring optimum creep resistance and/or resistance to hydrogen attack 1)	+600	A 691 - 1 CR Class 22 or 42 2) 3) 4)	-	-	-	-	-	-	1) For resistance to hydrogen attack, see API 941.
3.3.3	Electric-fusion-welded 1.25 Cr-0.5 Mo steel pipe in sizes DN400 and larger For high service temperatures, requiring optimum creep resistance and/or resistance to hydrogen attack 1)	+600	A 691 - 1.25 CR Class 22 or 42 2) 3) 4) 5)	-	-	-	-	-	-	2) For Class 22, base material to be in N & T or Q & T condition, with tempering at 730 °C min. Welds to be PWHT in range 680-780 °C.
3.3.4	Electric-fusion-welded steel pipe in sizes DN400 and larger For high service temperatures, requiring optimum creep resistance and/or resistance to hydrogen attack 1)	+625	A 691 - 2.25 CR Class 22 or 42 2) 3) 4)	-	-	-	-	-	-	3) For Class 42, tempering temperature to be 680 °C min. 4) Specify: Cu 0.20% max., Ni 0.30% max. $(\%Si+\%Mn) \leq 1.10$ $(\%Si+\%Mn) \times (\%P+\%Sn) \times 10^4 \leq 150$. For weld metal, specify: $10P+5Sb+4Sn+As \leq 1500$, where values are in mg/kg. 5) Specify P 0.005% max.
3.3.5	Electric-fusion-welded 5 Cr-0.5 Mo steel pipe in sizes DN400 and larger For high service temperatures and/or resistance to sulphur corrosion	+650	A 691 - 5 CR Class 22 or 42 2) 3)	-	-	-	-	-	-	

3. FERROUS METALS - ALLOYED (Cont'd)

3.3 PIPE (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.3.6	Electric-fusion-welded 18 Cr-8 Ni steel pipe in sizes above DN300 For certain corrosive conditions and/or high service temperatures	-200 +400 1)	A 358 - Grade 304 Class 1 2) A 358 - Grade 304L Class 1 2)	-	-	-	-	-	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E . 3) For optimum resistance to intergranular corrosion, specify a stabilization heat treatment at 950 °C subsequent to solution heat treatment, as detailed in ASTM A358 Supplementary Requirement S5.
3.3.7	Electric-fusion-welded 18 Cr-8 Ni stabilized steel pipe in sizes above DN300 For certain corrosive conditions and/or high service temperatures	(-100) +600	A 358 - Grade 321 Class 1 2) 3) A 358 - Grade 347 Class 1 2) 3)	- -	- -	- -	- -	-	- -	
3.3.8	Electric-fusion-welded 18 Cr-10 Ni-2 Mo steel pipe in sizes above DN300 For certain corrosive conditions and/or high service temperatures	-200 +500 1)	A 358 - Grade 316 Class 1 2) 3) A 358 - Grade 316L Class 1 2) 3)	-	-	-	-	-	-	
3.3.9	Electric-fusion-welded 18 Cr-8 Ni steel pipe in sizes above DN300 For certain corrosive conditions and/or high service temperatures	(-200) (+500)	A 358 - Grade 304L Class 1 1)	-	-	-	-	-	-	1) Specify C 0.06% max. and Mo+Ti+Nb 0.04% max.
3.3.10	Seamless 0.3 Mo steel pipe For high service temperatures	+500	-	-	17175: 15 Mo 3 1)	A 49-213 TU 15 D3 1)	-	-	2604-2 TS 26 1)	**NOT** for hydrogen service. 1) Specify total Al content 0.012% max.

3. FERROUS METALS - ALLOYED (Cont'd)

3.3 PIPE (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.3.11	Seamless 0.5 Mo steel pipe For high service temperatures	+500	A 335 - P1 1)	-	-	-	G 3458 STPA 12 1)	16Mo 1)	-	**NOT** for hydrogen service. Seamless usually not obtainable in sizes larger than DN400. For larger sizes use ASTM A672-L65 Class 32 (3.3.1). 1) Specify total Al content 0.012% max.
3.3.12	Seamless 1 Cr-0.5 Mo steel pipe For high service temperatures and/or resistance to hydrogen attack 1)	+600	A 335 - P12 3) 4)	3604: HFS 620-440 Cat. 2 3) 4)	17175: 13 CrMo 4 4 2) 3) 4)	A 49-213 TU 13 CD 4-04 2) 3) 4)	G 3458 STPA 22 3) 4)	15CrMo 4)	2604-2 TS 32 3) 4)	Seamless usually not obtainable in sizes larger than DN400. For larger sizes use ASTM A691 - 1 CR-Class 22 or 42 (see 3.3.2). 1) For resistance to hydrogen attack, see API 941. 2) Where resistance to hydrogen attack is required specify Cr content to be 0.8% min. 3) Specify to be normalized and tempered or quenched and tempered. 4) Specify: Cu 0.20% max., Ni 0.30% max. (%Si+%Mn) ≤ 1.10 (%Si+%Mn) x (%P+%Sn) x 10^4 ≤150.
3.3.13	Seamless 1.25 Cr- 0.5 Mo steel pipe For high service temperatures and/or resistance to hydrogen attack 1)	+600	A 335 - P11 2) 3) 4)	3604: HFS 621 Cat. 2 2) 3) 4)	-	A 49-213 TU 10 CD 5-05 2) 3) 4)	G 3458 STPA 23 2) 3) 4)	-	-	Seamless usually not obtainable in sizes larger than DN400. For larger sizes use ASTM A691-1.25 CR-Class 22 or 42 (3.3.3). 1) For resistance to hydrogen attack, see API 941. 2) Specify to be normalized and tempered or quenched and tempered. 3) Specify: Cu 0.20% max., Ni 0.30% max. (%Si+%Mn) ≤ 1.10 (%Si+%Mn) x (%P+%Sn) x 10^4 ≤ 150. 4) Specify P 0.005% max.

3. FERROUS METALS - ALLOYED (Cont'd)

3.3 PIPE (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	**GB (CHINA)**	ISO	REMARKS
3.3.14	Seamless 2.25 Cr-1 Mo steel pipe For high service temperatures, requiring optimum creep resistance and/or resistance to hydrogen attack 1)	+625	A 335 - P22 2) 3)	3604: HFS 622 Cat. 2 2) 3)	17175: 10 CrMo 9 10 2) 3)	A 49-213 TU 10 CD 9-10 2) 3)	G 3458 STPA 24 2) 3)	-	2604-2 TS 34 2) 3)	Seamless usually not obtainable in sizes larger than DN400. For larger sizes use ASTM A691 - 2.25 CR-Class 22 or 42 (see 3.3.4). 1) For resistance to hydrogen attack, see API 941. 2) Specify to be normalized and tempered or quenched and tempered. 3) Specify: Cu 0.20% max., Ni 0.30% max. (%Si+%Mn) ≤ 1.10 (%Si+%Mn) x (%P+%Sn) x 10^4 ≤ 150.
3.3.15	Seamless 5 Cr-0.5 Mo steel pipe For high service temperatures and/or resistance to sulphur corrosion	+650	A 335 - P5 1)	3604: HFS 625 Cat. 2 1)	-	A 49-213 TUZ 12 CD 05-05 1)	G 3458 STPA 25 1)	1Cr5Mo 1) 2)	2604-2 TS 37 1)	Seamless usually not obtainable in sizes larger than DN400. For larger sizes use ASTM A691 - 5 CR-Class 22 or 42 (see 3.3.5). 1) Specify to be normalized and tempered or quenched and tempered. 2) Maximum 600 °C
3.3.16	Seamless 9 Cr-1 Mo steel pipe For high service temperatures and/or resistance to sulphur corrosion	+650	A 335 - P9 1)	3604: HFS 629-470 1)	-	A 49-213 TUZ 10 CD 09 1)	G 3458 STPA 26 1)	-	2604-2 TS 38 1)	1) Specify to be normalized and tempered or quenched and tempered
3.3.17	Seamless 3.5 Ni steel pipe For low service temperatures	(+400) 1)	A 333 - Grade 3 Seamless	3603: HFS 503 LT Cat. 2	17173: 10 Ni 14	A 49-230 TU 10 N 14	G 3460 STPL 450	-	2604-2 TS 43	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
3.3.18	Seamless 9 Ni steel pipe For low service temperatures 2)	-200 1)	A 333 - Grade 8 Seamless	3603: HFS 509 LT Cat. 2	17173: X 8 Ni 9	A 49-230 TUZ 6 N 9	G 3460 STPL 690	-	2604-2 TS 45	2) Specify C 0.10% max. S 0.002% max. P 0.005% max.

3. FERROUS METALS - ALLOYED (Cont'd)

3.3 PIPE (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.3.19	Seamless and welded 18 Cr-8 Ni steel pipe in sizes to DN300 incl. For low service temperatures or to prevent product contamination	-200 +400 1)	A 312 - TP 304 2) 4)	3605: CFS 304S31 and LWHT 304S31 2) 4)	17458/57: X 5 CrNi 18 10 2) 4)	-	G 3459 SUS 304 TP 2) 3) 4)	0Cr18Ni9 2) 3) 4)	2604-2 TS 47 4) 2604-5 TFW 47 - LWHT 2) 4)	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) Welded pipe may be used up to and including 5.5 mm wall thickness.
3.3.20	Seamless and welded 18 Cr- 8 Ni steel pipe in sizes to DN300 incl. For certain corrosive conditions and/or high service temperatures	-200 +400 1)	A 312 - TP 304L 2) 4)	3605: CFS 304S11 and LWHT 304S11 2) 4)	17458/57: X 2 CrNi 19 11 2) 4)	-	G 3459 SUS 304 LTP 2) 3) 4)	00Cr19Ni10 2) 3) 4)	2604-2 TS 46 4) 2604-5 TFW 46 - LWHT 2) 4)	3) For welded pipe, specify automatic arc welded. 4) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334.
3.3.21	Seamless and welded 18 Cr-8 Ni steel pipe in sizes to DN300 incl. For certain corrosive conditions and/or high service temperatures	(-100) +600	A 312 - TP 321 2) 4) 5) A 312 - TP 347 2) 4) 5)	3605: CFS 321S31 and LWHT 321S31 2) 4) 5) 3605: CFS 347S31 and LWHT 347S31 2) 4) 5)	17458/57: X 6 CrNiTi 18 10 2) 4) 5) 17458/57: X 6 CrNiNb 18 10 2) 4) 5)	- -	G 3459 SUS 321 TP 2) 3) 4) 5) G 3459 SUS 347 TP 2) 3) 4) 5)	0Cr18Ni10Ti 2) 3) 4) 5) 0Cr18Ni11Nb 2) 3) 4) 5)	2604-2 TS 53 4) 5) 2604-5 TFW 53 - LWHT 2) 4) 5) 2604-2 TS 50 4) 5) 2604-5 TFW 50 - LWHT 2) 4) 5)	5) For optimum resistance to intergranular corrosion, specify a stabilization heat treatment at 950 °C subsequent to solution heat treatment, as detailed in ASTM A358 Supplementary Requirement S5.

3. FERROUS METALS - ALLOYED (Cont'd)

3.3 PIPE (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.3.22	Seamless and welded 18 Cr-8 Ni stabilized steel pipe in sizes to DN300 incl. For certain corrosive conditions and/or extreme service temperatures	+815	A 312 - TP 321H 2) 3) A 312 - TP 347H 2) 3)	3605: CFS 321S51 3605: CFS 347S51	- -	- -	G 3459 SUS 321 HTP 2) 3) 4) G 3459 SUS 347 HTP 2) 3) 4)	-	2604-2 TS 54 3) 2604-2 TS 56 3)	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) Welded pipe may be used up to and including 5.5 mm.
3.3.23	Seamless and welded 18 Cr-10 Ni-2 Mo steel pipe in sizes to DN300 incl. For certain corrosive conditions and/or high service temperatures	-200 +500 1)	A 312 - TP 316 2) 5) A 312 - TP 316L 2) 5)	3605: CFS 316S31 and LWHT 316S31 2) 5) 3605: CFS 316S11 and LWHT 316S11 2) 5)	17458/57: X 5 CrNiMo 17 12 2 2) 5) 17458/57: X 2 CrNiMo 17 13 2 2) 5)	- -	G 3459 SUS 316 TP 2) 4) 5) G 3459 SUS 316 LTP 2) 4) 5)	0Cr17Ni12-Mo2 2) 4) 5) 00Cr17Ni14-Mo2 2) 4) 5)	2604-2 TS 60 5) 2604-5 TFW 60- LWHT 2) 5) 2604-2 TS 57 5) 2604-5 TFW 57- LWHT 2) 5)	3) The use of this grade is subject to agreement of the Principal. 4) For welded pipe, specify automatic arc welded. 5) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E <u>or</u> <u>GB 4334</u>.
3.3.24	Seamless and welded 18 Cr-8 Ni steel pipe in sizes to DN300 incl. For certain corrosive conditions and/or high service temperatures	+500 (+815)	A 312 - TP 304H 1)	3605: CFS 304S51 1)	-	-	G 3459 SUS 304 HTP 1)	-	2604-2 TS 48 1)	1) Specify C 0.06% max. and Mo+Ti+Nb 0.4% max.
3.3.25	Seamless and welded 22 Cr-5 Ni-Mo-N steel pipe For certain corrosive conditions	+300 1)	A 790 - S 31803 2) 3)	-	-	-	G 3459 SUS 329 J2LTP 2) 3) 4)	-	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
3.3.26	Seamless and welded 25 Cr-7 Ni-Mo-N steel pipe For certain corrosive conditions	+300 1)	A 790 - S 32750 2) 3)	-	-	-	-	-	-	2) Specify N 0.15% min. 3) Welded pipe may be used up to and including 5.5 mm wall thickness.
3.3.27	Seamless and welded 20 Cr-18 Ni-6 Mo-Cu-N steel pipe For certain corrosive conditions	-200 (+400) 1)	A 312 - S31254 3)	-	-	-	-	-	-	4) For welded pipe, specify automatic arc welded.

3. FERROUS METALS - ALLOYED (Cont'd)

3.4 FORGINGS, FLANGES AND FITTINGS

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.4.1	0.5 Mo steel butt-welding fittings For high service temperatures	+500	A 234 - WP1 or WP1W 1)	1640: WP1 1)	-	-	-	-	-	**NOT** for hydrogen service Sizes up to DN400 incl. shall be seamless. Larger sizes may be either seamless or welded. 1) Specify total Al content 0.012% max.
3.4.2	1 Cr-0.5 Mo steel butt-welding fittings For high service temperatures and/or resistance to hydrogen attack 1)	+600	A 234 - WP12 Class 2 or WP12W Class 2 2) 3)	-	-	-	-	-	-	Sizes up to DN400 incl. shall be seamless. Larger sizes may be either seamless or welded. 1) For resistance to hydrogen attack, see API 941. 2) Specify to be normalized and tempered or quenched and tempered.
3.4.3	1.25Cr-0.5Mo steel butt-welding fittings For high service temperatures and/or resistance to hydrogen attack 1)	+600	A 234 - WP11 Class 2 or WP11W Class 2 2) 3) 4)	1640: WP11 2) 3) 4)	-	-	-	-	-	
3.4.4	2.25 Cr-1 Mo steel butt-welding fittings For extreme service temperatures and/or resistance to sulphur corrosion 1)	+625	A 234 - WP22 Class 3 or WP22W Class 3 2) 3)	1640: WP22 2) 3)	-	-	-	-	-	3) Specify: Cu 0.20% max., Ni 0.30% max. (%Si+%Mn) ≤ 1.10 (%Si+%Mn) x (%P+%Sn) x 10^4 ≤ 150. For weld metal, specify: 10P+5Sb+4Sn+As ≤ 1500, where values are in mg/Kg 4) Specify P 0.005% max.
3.4.5	5 Cr-0.5 Mo steel butt-welding fittings For high service temperatures and/or resistance to sulphur corrosion	+650	A 234 - WP5 or WP5W 1)	1640: WP5 1)	-	-	-	-	-	Sizes up to DN400 incl. shall be seamless. Larger sizes may be either seamless or welded. 1) Specify to be normalized and tempered or quenched and tempered.

3. FERROUS METALS - ALLOYED (Cont'd)

3.4 FORGINGS, FLANGES AND FITTINGS (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.4.6	3.5 Ni steel butt-welding fittings For low service temperatures	(+400) 1)	A 420 - WPL3 or WPL3W 2)	1640: WPL3 2)	-	-	-	-	-	Sizes up to DN400 incl. shall be seamless. Larger sizes may be either seamless or welded. 1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) Specify to be normalized.
3.4.7	9 Ni steel butt-welding fittings For low service temperatures	-200 1)	A 420 - WPL8 or WPL8W 2) 3)	-	-	-	-	-		Sizes up to DN400 incl. shall be seamless. Larger sizes may be either seamless or welded. 1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) Specify to be double-normalized and tempered or quenched and tempered. 3) Specify C 0.10% max. S 0.002% max. P 0.005% max.
3.4.8	18 Cr-8 Ni steel butt-welding fittings For low service temperatures or to prevent product contamination	-200 +400 1)	A 403 - WP304 -S/WX/WU 2)	1640: WP304 2)	-	-	-	-	-	Sizes up to DN400 incl. shall be seamless. Larger sizes may be either seamless or welded.
3.4.9	18 Cr-8 Ni steel butt-welding fittings For certain corrosive conditions and/or high service temperatures	-200 +400 1)	A 403 - WP304L -S/WX/WU 2)	1640: WP304L 2)	-	-	-	-	-	1) For low- temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E.

3. FERROUS METALS - ALLOYED (Cont'd)

3.4 FORGINGS, FLANGES AND FITTINGS (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	**GB (CHINA)**	ISO	REMARKS
3.4.10	18 Cr-8 Ni steel butt-welding fittings For certain corrosive conditions and/or extreme service temperatures	+815	A 403 - WP304H -S/WX/WU 1)	-	-	-	-	-	-	Sizes up to DN400 incl. shall be seamless. Larger sizes may be either seamless or welded. 1) Specify C 0.06% max. and Mo+Ti+Nb 0.4% max. 2) The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E. 3) For optimum resistance to intergranular corrosion, specify a stabilization heat treatment at 950 °C subsequent solution heat treatment.
3.4.11	18 Cr-8 Ni stabilized steel butt-welding fittings For certain corrosive conditions and/or extreme service temperatures	(-100) +600	A 403 - WP321 -S/WX/WU 2) 3) A 403 - WP347 -S/WX/WU 2) 3)	1640: WP321 2) 3) 1640: WP321 2) 3)	-	-	-	-	-	
3.4.12	18 Cr-8 Ni stabilized steel butt-welding fittings For certain corrosive conditions and/or extreme service temperatures	+815	A 403 - WP321H -S/WX/WU 1) A 403 - WP347H -S/WX/WU 1)	- -	- -	- -	- -	- -	- -	1) The use of this grade is subject to agreement of the Principal.
3.4.13	18 Cr-10 Ni-2 Mo steel butt-welding fittings For certain corrosive conditions and/or high service conditions	-200 +500 1)	A 403 - WP316 -S/WX/WU 2) A 403 - WP316L -S/WX/WU 2)	1640: WP316 2) 1640: WP316L 2)	- -	- -	- -	- -	- -	Sizes up to DN400 incl. shall be seamless. Larger sizes may be either seamless or welded. 1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E .

3. FERROUS METALS - ALLOYED (Cont'd)

3.4 FORGINGS, FLANGES AND FITTINGS (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	**GB (CHINA)**	ISO	REMARKS
3.4.14	22 Cr-5 Ni-Mo-N steel butt-welding fittings For certain corrosive conditions	+300 1)	A 815 - S31803 Class WP-S or WP-WX 2)	-	-	-	-	-	-	Sizes up to DN400 incl. Shall be seamless. Larger sizes may be either seamless or welded. 1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) N 0.15% min.
3.4.15	20 Cr-18 Ni-6 Mo-Cu-N steel butt-welding fittings For certain corrosive conditions	(-200) (+400) 1)	A 403 - WPS31254 -S/WX/WU	-	-	-	-	-	-	Sizes up to DN400 incl. shall be seamless. Larger sizes may be either seamless or welded. 1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
3.4.16	0.5 Mo steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts at high service temperatures	+500	A 182 - F1	-	-	-	G 3203 SFVA F1	-	2604-1 F28 or F29	**NOT** for hydrogen service 1) Specify total Al content 0.012% max.
3.4.17	0.5 Mo steel forgings For heavy parts, e.g. drum forgings, for high service temperatures	+500	A 336 - F1 1)	-	-	-	G 3203 SFVA F1 1)	-	2604-1 F29 1)	
3.4.18	1 Cr-0.5 Mo steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts at high service temperatures and/or requiring resistance to hydrogen attack 1)	+600	A 182 - F12 Class 2 2) 5)	1503: 620-440 2) 5)	17243: 13 CrMo 44 2) 3) 4) 5)	A 36-602 15 CD 4.05 2) 4) 5))	G 3203 SFVA F12 2) 5)	15CrMo 5)	2604-1 F32 2) 5)	1) For resistance to hydrogen attack, see API 941. 2) Specify to be normalized and tempered or quenched and tempered.

3. FERROUS METALS - ALLOYED (Cont'da)

3.4 FORGINGS, FLANGES AND FITTINGS (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.4.19	1 Cr-0.5 Mo steel forgings For heavy parts, e.g. drum forgings, for high service temperatures and/or requiring resistance to hydrogen attack 1)	+600	A 336 - F12 2) 5)	1503: 620-440 2) 5)	17243: 13 CrMo 44 2) 3) 4) 5)	A 36-602 15 CD 4.05 2) 4) 5)	G 3203 SFVA F12 2) 5)	15CrMo 5)	2604-1 F32 2) 5)	3) When resistance to hydrogen attack is required, specify Cr content to be 0.8% min. 4) Specify 0.45% Mo min. for hydrogen service. 5) Specify: Cu 0.20% max., Ni 0.30% max. (%Si+%Mn) ≤ 1.10 (%Si+%Mn) x (%P+%Sn) x 10^4 ≤ 150. 6) Specify P 0.005% max.
3.4.20	1.25 Cr-0.5Mo steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts at high service temperatures and/or requiring resistance to hydrogen attack 1)	+600	A 182 - F11 2) 5) 6)	1503: 621-460 2) 5) 6)	-	-	G 3203 SFVA F11A 2) 5) 6)	-	-	
3.4.21	1.25 Cr-0.5 Mo steel forgings For heavy parts, e.g. drum forgings, for high service temperatures and/or requiring resistance to hydrogen attack 1)	+600	A 336 - F11 2) 5) 6)	1503: 621-460 2) 5) 6)	-	-	G 3203 SFVA F11A 2) 5) 6)	-	-	
3.4.22	2.25 Cr-1 Mo steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts at high service temperatures and/or requiring resistance to hydrogen attack 1)	+625	A 182 - F22 2) 5)	1503: 622-560 2) 5)	17243: 10 CrMo 9 10 2) 5)	A 36-602 10 CD 9.10 2) 5)	G 3203 SFVA F22B 2) 5)	-	2604-1 F34 2) 5))	
3.4.23	2.25 Cr-1 Mo steel forgings For heavy parts, e.g. drum forgings, for high service temperatures and/or requiring resistance to hydrogen attack 1)	+625	A 336 - F22 2) 5)	1503: 622-560 2) 5)	17243: 10 CrMo 9 10 2) 5)	A 36-602 10 CD 9.10 2) 5)	G 3203 SFVA F22B 2) 5)	-	2604-1 F34 2) 5)	

3. FERROUS METALS - ALLOYED (Cont'd)

3.4 FORGINGS, FLANGES AND FITTINGS (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.4.24	3 Cr-1 Mo steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts at high service temperatures, requiring optimum creep resistance and/or requiring resistance to hydrogen attack 1)	+625	A 182 - F21 2) 3)	-	-	A 36-602 10 CD 12.10 2) 3)	G 3203 SFVA F21B 2) 3)	-	-	1) For resistance to hydrogen attack, see API 941. 2) Specify to be normalized and tempered or quenched and tempered. 3) Specify: Cu 0.20% max., Ni 0.30% max. (%Si+%Mn) ≤1.10 (%Si+%Mn) x (%P+%Sn) x 10^4 ≤ 150.
3.4.25	5 Cr-0.5 Mo steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts at extreme service temperatures and/or requiring resistance to sulphur corrosion	+650	A 182 - F5 2)	1503: 625-590 2)	-	A 36-602 Z 10 CD 5.05 2)	G 3203 SFVA F5B 2)	1Cr5Mo	2604-1 F37 2)	
3.4.26	3.5 Ni steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts at low service temperatures	(+400) 1)	A 350 - LF 3	1503: 503-490	17280: 10 Ni 14	-	G 3205 SFL 3	-	2604-1 F44	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
3.4.27	9 Ni steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts at low service temperatures	-200 1)	A 522 - Type I 2)	1503: 509-690 2)	17280: X 8 Ni 9 2)	-	-	-	2604-1 F45 2)	2) Specify C 0.10% max. Si 0.30% max. P 0.002% max. S 0.005% max.
3.4.28	12 Cr steel forgings For certain corrosive conditions	+540	A 182 - F6a	970: 410S21	17440: X 10 Cr 13	-	G 3214 SUS F410	0Cr13	-	
3.4.29	12 Cr steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts under certain corrosive conditions and/or at high service temperatures	+540	A 182 - F6a	1503: 410S21	17440: X 10 Cr 13	-	G 3214 SUS F410	0Cr13	-	

3. FERROUS METALS - ALLOYED (Cont'd)

3.4 FORGINGS, FLANGES AND FITTINGS (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.4.30	18 Cr-8 Ni steel forgings For low service temperatures or to prevent product contamination	-200 +400 1)	A 182 - F304 2)	970: 304S31 2)	17440: X 5 CrNi 18 10 2)	A 36-607 Z 6 CN 18-09 2)	G 3214 SUS F304 2)	0Cr18Ni9 2)	2604-1 F49 2)	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334.
3.4.31	18 Cr-8 Ni steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts at low service temperatures or to prevent product contamination	-200 +400 1)	A 182 - F304 2)	1503: 304S31 2)	17440: X 5 CrNi 18 10 2)	A 36-607 Z 6 CN 18-09 2)	G 3214 SUS F304 2)	0Cr18Ni9 2)	2604-1 F49 2)	
3.4.32	18 Cr-8 Ni steel forgings For certain corrosive conditions and/or high service temperatures	-200 +500 1)	A 182 - F304L 2)	970: 304S11 2)	17440: X 2 CrNi 19 11 2)	A 36-607 Z 2 CN 18-10 2)	G 3214 SUS F304L 2)	00Cr19Ni10 2)	2604-1 F46 2)	
3.4.33	18 Cr-8 Ni steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts under certain corrosive conditions and/or at high service temperatures	-200 +500 1)	A 182 - F304L 2)	1503: 304S11 2)	17440: X 2 CrNi 19 11 2)	A 36-607 Z 2 CN 18-10 2)	G 3214 SUS F304L 2)	00Cr19Ni10 2)	2604-1 F46 2)	
3.4.34	18 Cr-8 Ni steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts under certain corrosive conditions and/or at extreme service temperatures	+815	A 182 - F304H 1)	1503: 304S51 1)	-	-	G 3214 SUS F304H 1)	-	2604-1 F48 1)	1) Specify C 0.06% max. and Mo+Ti+Nb 0.4% max.

3. FERROUS METALS - ALLOYED (Cont'd)

3.4 FORGINGS, FLANGES AND FITTINGS (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.4.35	18 Cr-8 Ni stabilized steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts under certain corrosive conditions and/or at high service temperatures	+600	A 182 - F321 1) 2) A 182 - F347 1) 2)	1503: 321S31 1) 2) 1503: 347S31 1) 2)	17440: X 6 CrNiTi 18 10 1) 2) 17440: X 6 CrNiNb 18 10 1) 2)	A 36-607 Z 6 CNT 18-10 1) 2) A 36-607 Z 6 CNNb 18-10 1) 2)	G 3214 SUS F321 1) 2) G 3214 SUS F347 1) 2)	0Cr18Ni10Ti 1) 2)	2604-1 F55 1) 2) 2604-1 F52 1) 2)	1) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334. 2) For optimum resistance to intergranular corrosion, specify a stabilization heat treatment at 950 °C, subsequent to solution heat treatment.
3.4.36	18 Cr-8 Ni stabilized steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts under certain corrosive conditions and/or at extreme service temperatures	+815	A 182 - F321H 1) A 182 - F347H 1)	1503: 321S51-490 1) 1503: 347S51 1)	- -	- -	G 3214 SUS F321H 1) G 3214 SUS F347H 1)	- -	2604-1 F54A 1) 2604-1 F51 1)	1) The use of this grade is subject to agreement of the Principal.
3.4.37	18 Cr-10 Ni-2 Mo steel forgings For certain corrosive conditions and/or high service temperatures	-200 +500 1)	A 182 - F316 2)	970: 316S31 2)	17440: X 5 CrNiMo 17 12 2 2)	A 36-607 Z 6 CND 17-11 2)	G 3214 SUS F316 2)	0Cr17Ni12-Mo2 2)	2604-1 F62 2)	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
3.4.38	18 Cr-10 Ni-2 Mo steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts under certain corrosive conditions and/or at high service temperatures	-200 +500 1)	A 182 - F316 2)	1503: 316S31 2)	17440: X 5 CrNiMo 17 12 2 2)	A 36-607 Z 6 CND 17-11 2)	G 3214 SUS F316 2)	0Cr17Ni12-Mo2 2)	2604-1 F62 2)	2) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334.
3.4.39	18 Cr-10 Ni-2 Mo steel forgings For certain corrosive conditions and/or high service temperatures	-200 +500 1)	A 182 - F316L 2)	970: 316S11 2)	17440: X 2 CrNiMo 17 13 2 2)	A 36-607 Z 2 CND 17-11 2)	G 3214 SUS F316L 2)	00Cr17Ni14-Mo2 2)	2604-1 F59 2)	

3. FERROUS METALS - ALLOYED (Cont'd)

3.4 FORGINGS, FLANGES AND FITTINGS (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.4.40	18 Cr-10 Ni-2 Mo steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts under certain corrosive conditions and/or at high service temperatures	-200 +500 1)	A 182 - F316L 2)	1503: 316S11 2)	17440: X 2 CrNiMo 17 13 2 2)	A 36-607 Z 2 CND 17-11 2)	G 3214 SUS F316L 2)	00Cr17Ni14-Mo2 2)	2604-1 F59 2)	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334.
3.4.41	22 Cr-5 Ni- Mo-N steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts under certain corrosive conditions.	(-30) +300 1)	A 182 - F51 3)	1503: 318 S13 3)	SEW 400: X 2 CrNiMo N 22 5 3 3)	-	-	-	-	3) N 0.15% min.
3.4.42	25 Cr-7 Ni-Mo-N steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts under certain corrosive conditions.	(-30) +300 1)	A 182 - F53	-	-	-	-	-	-	
3.4.43	20 Cr-18 Ni-6 Mo-Cu-N steel forgings For tube sheets, flanges, fittings, valves and other pressure-retaining parts under certain corrosive conditions.	(-200) (+400) 1)	A 182 - F44	-	-	-	-	-	-	

3. FERROUS METALS - ALLOYED (Cont'd)

3.5 CASTINGS

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.5.1	14.5 Si iron castings For non-pressure-retaining (internal) parts in acid service	+250	A 518 - 1 1)	1591: Si14 1)	-	-	-	-	-	1) Si content 14.5% min. Other alloying elements, e.g. Mo, may be added.
3.5.2	15 Ni-6 Cu-2 Cr-Fe (Ni-Resist Type 1) iron castings For non-pressure-retaining (internal) parts under certain corrosive conditions	+500	A 436 - Type 1	3468: F1	1694: GGL NiCuCr 15 6 2	A 32-301 L-NUC 15 6 2	-	-	2892: L-NiCuCr 15 6 2	
3.5.3	20 Ni-2 Cr ductile iron (Ni-Resist Type D-2) castings For pressure-retaining parts under certain corrosive conditions	+500	A 439: Type D-2	3468: S2	1694: GGG NiCr 20 2	A 32-301 S-NC 20 2	-	-	2892: S-NiCr 20 2	
3.5.4	22 Ni-4 Mn ductile iron (Ni-Resist Type D-2M) castings For pressure-retaining parts at low service temperatures	-105 +500 1)	A 571: Type D-2M	3468: S2M	1694: GGG NiMn 23 4	A 32-301 S-NM 23 4	-	-	2892: S-NiMn 23 4	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
3.5.5	0.5 Mo steel castings For fittings, valves and other pressure-retaining parts at high service temperatures	+500	A 217 - WC1 1)	1504: 245 1)	-	A 32-055 20 D5-M 1) 2)	G 5151 SCPH 11 1)	-	-	**NOT** for hydrogen service 1) Specify total Al content 0.012% max. 2) Specify 0.45% Mo min. for hydrogen service.
3.5.6	1.25 Cr-0.5 Mo steel castings For fittings, valves and other pressure-retaining parts at high service temperatures and/or requiring resistance to hydrogen attack 1)	+600	A 217 - WC6 2) 3)	1504: 621 2) 3)	17245: GS-17 CrMo 5 5 2) 3)	A 32-055 15 CD5.05-M 2) 3)	G 5151 SCPH 21 2) 3)	-	-	1) For resistance to hydrogen attack, see API 941. 2) Specify to be normalized and tempered or quenched and tempered. 3) Specify P 0.005% max.
3.5.7	2.25 Cr-1 Mo steel castings For fittings, valves and other pressure-retaining parts at extreme service temperatures requiring optimum creep resistance and/or resistance to hydrogen attack 1)	+625	A 217 - WC9 2)	1504: 622 2)	17245: GS-18 CrMo 9 10 2)	A 32-055 15 CD9.10-M 2)	G 5151 SCPH 32 2)	-	-	

3. FERROUS METALS - ALLOYED (Cont'd)

3.5 CASTINGS (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.5.8	5 Cr-0.5 Mo steel castings For fittings, valves and other pressure-retaining parts at high service temperatures and/or requiring resistance to sulphur corrosion	+650	A 217 - C5 1)	1504: 625 1)	SEW 595: GS-12 CrMo 19 5 1)	A 32-055 Z 15 CD5.05-M 1)	G 5151 SCPH 61 1)	-	-	1) For resistance to hydrogen attack, see API 941.
3.5.9	9 Cr-1 Mo steel castings For fittings, valves and other pressure-retaining parts at high service temperatures and/or requiring resistance to sulphur corrosion	+650	A 217 - C12 1)	1504: 629 1)	SEW 595: G-X 12 CrMo 10 1 1)	-	-	-		
3.5.10	3.5 Ni steel castings For low service temperatures	(+400) 1)	A 352 - LC3	1504: 503LT60	SEW 685: GS-10 Ni 14	A 32-053 FC 3-M or A 32-055 20 N 12-M	G 5152 SCPL 31	-	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
3.5.11	9 Ni steel castings For low service temperatures	(+400) 1)	A 352 - LC9 2)	-	-	-	-	-	-	2) Specify C 0.10% max. S 0.002% max. P 0.005% max.
3.5.12	12 Cr steel castings For non-pressure-retaining parts under certain corrosive conditions	+540	A 743 - CA15	3100: 410C21	17445: G-X 20 Cr 14	A 32-059 Z 12 C 13-M	G 5121 SCS1	-	-	
3.5.13	12 Cr steel castings For pressure-retaining parts under certain corrosive conditions	+540	A 217 - CA15	1504: 420C29	17445: G-X 20 Cr 14	A 32-059 Z 12 C 13-M	G 5121 SCS1	-	-	
3.5.14	18 Cr-8 Ni steel castings For non-pressure-retaining (internal) parts under certain corrosive conditions and/or at high service temperatures	-200 +400 1)	A 744 - CF8 2)	3100: 304C15 2)	17445: G-X 6 CrNi 18 9 2)	A 32-056 Z 6 CN 18-10-M 2)	G 5121 SCS13A 2)	-	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) Castings for corrosive service shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E.
3.5.15	18 Cr-10 Ni-Nb stabilized steel castings For non-pressure-retaining (internal) parts under certain corrosive conditions and/or at high service temperatures	(-100) +600	A 744 - CF8C 2) 3)	3100: 347C17 2) 3)	17445: G-X 5 CrNiNb 18 9 2) 3)	A 32-056 Z 6 CNNb 18-10-M 2) 3)	G 5121 SCS21 2) 3)	-	-	3) If intended for working temperatures above 500 °C, specify Si content 1.0% max.

3. FERROUS METALS - ALLOYED (Cont'd)

3.5 CASTINGS (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.5.16	18 Cr-10 Ni-2 Mo steel castings For non-pressure-retaining (internal) parts under certain corrosive conditions and/or at high service temperatures	-200 +500 1)	A 744 - CF8M 2)	3100: 316C16 2)	17445: G-X 6 CrNiMo 18 10 2)	A 32-056 Z 6 CND 18-12-M 2)	G 5121 SCS14A 2)	-	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) Castings for corrosive service shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E. 3) If intended for working temperatures above 500 °C, specify Si content 1.0% max. 4) See DEP 31.24.40.31-CSPC. 5) Specify magnetic permeability 1.05 max.
3.5.17	25 Cr-20 Ni steel castings For non-pressure-retaining (internal) parts requiring heat resistance	+1000	A 297 - HK 4)	3100: 310C45 4)	17465: G-X 40 CrNiSi 25 20 4)	A 32-057 Z 40 CN 25.20-M 4)	G 5122 SCH22 4)	-	-	
3.5.18	25 Cr-12 Ni steel castings For furnace tube supports	+1000	A 447 - Type II 4)	3100: 309C32 4) 5)	-	-	G 5122 SCH13A 4)	-	-	
3.5.19	18 Cr-8 Ni steel castings For pressure-retaining parts under certain corrosive conditions and/or at high service temperatures	-200 +500 1)	A 351 - CF8 2)	1504: 304C15 2)	17445: G-X 6 CrNi 18 9 2)	A 32-056 Z 6 CN 18-10-M 2)	G 5121 SCS13A 2)	-	-	
3.5.20	18 Cr-8 Ni-Nb stabilized steel castings For pressure-retaining parts under certain corrosive conditions and/or at high service temperatures	(-100) +600	A 351 - CF8C 2) 3)	1504: 347C17 2) 3)	17445: G-X 5 CrNiNb 18 9 2) 3)	A 32-056 Z 6 CNNb 18-10-M 2) 3)	G 5121 SCS21 2) 3)	-	-	
3.5.21	18 Cr-10 Ni-2 Mo steel castings For pressure-retaining parts under certain corrosive conditions and/or at high service temperatures	-200 +500 1)	A 351 - CF8M 2)	1504: 316C16 2)	17445: G-X 6 CrNiMo 18 10 2)	A 32-056 Z 6 CND 18-12-M 2)	G 5121 SCS14A 2)	-	-	
3.5.22	22 Cr-5 Ni-Mo-N steel castings For pressure-retaining parts under certain corrosive conditions	+300	A 890 - 4A, S32 & S33	-	-	-	-	-	-	
3.5.23	25 Cr-7 Ni-Mo-N steel castings For pressure-retaining parts under certain corrosive conditions	+300	A 890 - 5A, S32 & S33	-	-	-	-	-	-	

3. FERROUS METALS - ALLOYED (Cont'd)

3.5 CASTINGS (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.5.24	20 Cr-18 Ni-6 Mo-Cu-N steel castings For pressure-retaining parts under certain corrosive conditions	(-200) (+400)	A 351 - CK3MCuN	-	-	-	-	-	-	
3.5.25	25 Cr-12 Ni steel castings For pressure-retaining parts under certain corrosive conditions at extreme service temperatures	+1000	A 351 - CH20 1)	-	-	-	G 5121 SCS17 1)	-	-	1) See DEP 31.24.40.31-CSPC.
3.5.26	25 Cr-20 Ni steel castings For pressure-retaining parts under certain corrosive conditions at extreme service temperatures	+1000	A 351 - CK20 1)	-	-	-	G 5121 SCS18 1)	-	-	
3.5.27	25 Cr-20 Ni steel castings For pressure-retaining parts under certain corrosive conditions at extreme service temperatures	+1000	A 351 - HK40 1)	1504: 310C40 1)	SEW: G-X 40 CrNiSi 25 20 1)	A 32-057 Z 40 CN 25.20-M 1)	G 5122 SCH22 1)	-	-	1) See DEP 31.24.40.31-CSPC.
3.5.28	20 Cr- 29 Ni-Mo-Cu steel castings For fittings, valves and other pressure-retaining parts requiring resistance to sulphuric acid corrosion	(+400)	A 744 - CN7M	1504: 332C11	-	-	G 5121 SCS23	-	-	
3.5.29	Cr-Ni steel centrifugal and static castings 20 Cr-33 Ni-Nb 25 Cr-20 Ni 25 Cr-35 Ni-Nb For pressure-retaining furnace parts at extreme service temperatures	1)	1)	-	-	-	-	-	-	1) See DEP 31.24.40.31-CSPC.

3. FERROUS METALS - ALLOYED (Cont'd)

3.6 BARS, SECTIONS AND WIRE

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.6.1	1 Cr-0.25 Mo steel bars For machined parts	+450 (+540)	A 322 - 4140	970: 708A40	17200: 42 CrMo 4	A 35-552 42 CD 4	G 4105 SCM 440	42CrMo	683-1 42 CrMo 4	
3.6.2	9 Ni steel bars For machined parts for low-temperature service	-200 1)	- -	1502: 509-650 1502: 509-690 4)	17280: X 8 Ni 9 2) 17280: X 8 Ni 9 3) 4)	- -	- -	-	- -	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) Double normalized and tempered condition. 3) Quenched and tempered condition. 4) Specify C 0.10% max. S 0.002% max. P 0.005% max.
3.6.3	12 Cr steel bars For machined parts	+425	A 276 - Type 410 1) A 276 - Type 420 1)	970: 410S21 970: 420S37	17440: X 15 Cr 13 17440: X 20 Cr 13	A 35-574 Z 10 C 13 A 35-574 Z 20 C 13	G 4303 SUS 410 G 4303 SUS 420J2	1Cr13 2Cr13	683-13 Type 1	1) Free-machining quality ASTM A582 Type 416 or 416Se acceptable, subject to approval by the Principal. For welded items specify Type 405.
3.6.4	18 Cr-8 Ni steel bars For machined parts	-200 +500 1)	A 479 - Type 304 2)	970: 304S31 2)	17440: X 5 CrNi 18 10 2)	A 35-574 Z 6 CN 18-09 2)	G 4303 SUS 304 2)	0Cr18Ni9 2)	683-13 Type 11 2)	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
3.6.5	18 Cr-8 Ni steel bars For machined parts	-200 +500 1)	A 479 - Type 304L 2)	970: 304S11 2)	17440: X 2 CrNi 19 11 2)	A 35-574 Z 2 CN 18-10 2)	G 4303 SUS 304L 2)	00Cr19Ni10 2)	683-13 Type 10 2)	2) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334.
3.6.6	18 Cr-8 Ni steel bars For machined parts	+500 (+815)	A 479 - Type 304H 1)	-	-	-	-	-	-	1) Specify C 0.06% max. and Mo+Ti+Nb 0.4% max.
3.6.7	18 Cr-8 Ni stabilized steel bars For machined parts	(-200) +815	A 479 - Type 321 2)	970: 321S31 2)	17440: X 6 CrNiTi 18 10	A 35-574 Z 6 CNT 18-10 2)	G 4303 SUS 321 2)	0Cr18Ni10Ti 2)	683-13 Type 15 2)	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	**GB (CHINA)**	ISO	REMARKS
			A 479 - Type 347 2)	970: 347S31 2)	2) 17440: X 6 CrNiNb 18 10 2)	-	G 4303 SUS 347 2)	0Cr18Ni11Nb 2)	683-13 Type 16 2)	2) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334.

3. FERROUS METALS - ALLOYED (Cont'd)

3.6 BARS, SECTIONS AND WIRE (CONT'D)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.6.8	18 Cr-8 Ni stabilized steel bars For machined parts	+500 (+815)	A 479 - Type 321H 1)	-	-	-	-	-	-	1) The use of this grade is subject to agreement of the Principal
			A 479 - Type 347H 1)	-	-	-	-	-	-	
3.6.9	18 Cr-10 Ni-2 Mo steel bars For machined parts	-200 +500 1)	A 479 - Type 316 2)	970: 316S31 2)	17440: X 5 CrNiMo 17 12 2 2)	A 35-574 Z 7 CND 17-11-02 2)	G 4303 SUS 316 2)	0Cr17Ni12-Mo2 2)	683-13 Type 20 2)	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334.
3.6.10	18 Cr-10 Ni-2 Mo steel bars For machined parts	-200 +500 1)	A 479 - Type 316L 2)	970: 316S11 2)	17440: X 2 CrNiMo 17 13 2 2)	A 35-574 Z 3 CND 17-11-02	G 4303 SUS 316L 2)	00Cr17Ni12-Mo2 2)	683-13 Type 19 2)	
3.6.11	22 Cr-5 Ni-Mo-N steel bars For machined parts	-30 +300 1)	A 479 - S31803 2)	-	-	-	-	-	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC 2) N 0.15% min.
3.6.12	25 Cr-7 Ni-Mo-N steel bars For machined parts	-30 +300 1)	A 479 - S32750	-	-	-	-	-	-	
3.6.13	20 Cr-18 Ni-6 Mo-Cu-N steel bars For machined parts	(-200) (+400) 1)	A 276 - S31254	-	-	-	-	-	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
3.6.14	Si-Mn steel bars For springs	+230	A 689/A 322-9260	970: 251A60	-	A 35-571 61 SC 7	G 4801 SUP 7	-	-	
3.6.15	Cold drawn steel wire For springs	(+230)	A 227	5216	17223	-	G 3521	-	-	
3.6.16	Cold drawn 18 Cr-8Ni steel wire For springs	-200 +230 1)	A 313 - Type 302 2)	2056: 302S26 2)	17224: X 12 CrNi 17 7 2)	A 35-574 Z 12 CN 18-09 2)	G 4314 SUS 302 2)	-	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E.

3. FERROUS METALS - ALLOYED (Cont'd)

3.7 BOLTING

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.7.1	1 Cr-0.25 Mo steel bolting material For general use	+450 (+540)	A 193 - B7	4882: B7	17200: 42 CrMo 4	A 35-557 42 CD 4	G 4107 SNB7	35CrMoA	683-1 42 CrMo 4 (Q+T)	For nuts see 2.7.3.
3.7.2	1 Cr-0.25 Mo steel bolting material For sour service	+450 (+540)	A 193 - B7M	4882: B7M	-	-	-	-	-	For nuts see 3.7.13.
3.7.3	1 Cr-0.5 Mo-0.25 V steel bolting material For high-temperature service	+525 (+600)	A 193 - B16	4882: B16	17240: 40 CrMoV 47	A 35-558 42 CDV 4	G 4107 SNB16	35CrMoVA	-	For nuts see 3.7.14.
3.7.4	1 Cr-0.25 Mo steel bolting material For low-temperature service	-105 +450 (+540) 1)	A 320 - L7	4882: L7	-	-	-	35CrMoA	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. For nuts see 3.7.15.
3.7.5	1 Cr-0.25 Mo steel bolting material For sour service **and** low-temperature service	-30 +450 1)	A 320 - L7M	4882: L7M	-	-	-	-	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. For nuts see 3.7.16.
3.7.6	9 Ni steel bolting material For low-temperature service	-200 1)	- -	4882: L9 4882: L9A	- -	- -	- -	-	- -	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. For nuts see 3.7.17.
3.7.7	12 Cr steel bolting material For certain corrosive conditions	+425 (+540)	A 193 - B6X	4882: B6	17440: X 20 Cr 13	A 35-574 Z 20 C 13	G 4303 SUS 420J2	2Cr13	-	For nuts see 3.7.18.
3.7.8	18 Cr-8 Ni steel (strain hardened) bolting material For certain corrosive conditions and/or extreme-temperature service	-200 +815 1)	A 193 - B8 Class 2 2)	4882: B8X 2)	17440: X 5 CrNi 18 10 2)	A 35-574 Z 6 CN 18-09 2)	G 4303 SUS 304 2)	0Cr18Ni9 2)	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) On completion of solution annealing, prior to strain hardening, the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334.

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	**GB (CHINA)**	ISO	REMARKS
										For nuts see 3.7.19.

3. FERROUS METALS - ALLOYED (Cont'd)

3.7 BOLTING (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.7.9	18 Cr-8 Ni stabilized steel bolting material For certain corrosive conditions and/or extreme-temperature service	-200 +815 1)	A 193 - B8T 2) A 193 - B8C 2)	4882: B8T 2) 4882: B8C 2)	17440: X 6 CrNiTi 18 10 2) 17440: X 6 CrNiNb 18 10 2)	A 35-574 Z 6 CNT 18-10 2) -	G 4303 SUS 321 2) G 4303 SUS 347 2)	0Cr18Ni10Ti 2)	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334. For nuts see 3.7.21.
3.7.10	18 Cr-10 Ni-2 Mo steel (strain hardened) bolting material For certain corrosive conditions and/or high-temperature service	-200 +500 1)	A 193 - B8M Class 2 2)	4882: B8MX 2)	17440: X 5 CrNiMo 17 12 2 2)	A 35-574 Z 7 CND 17-11-02 2)	G 4303 SUS 316 2)	0Cr17Ni12-Mo2 2)	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334. For nuts see 3.7.22.
3.7.11	18 Cr-8 Ni steel bolting material For low-temperature service	-200 1)	A 193 - B8N 2)	4882: B8N 2)	-	-	G 4303 SUS 304 N1 2)	-	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) The material shall be capable of meeting the requirements of ASTM A262 Practice E. For nuts see 3.7.20.
3.7.12	Precipitation harden-ing austenitic Ni-Cr steel bolting material For certain corrosive conditions and/or high-temperature service.	(+540)	A 453-660 Class A	4882: B17B	-	A 35-574 Z 6 NCTDV 25-15 B	G 4311 SUH 660	-	-	For nuts see 3.7.23.

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	**GB (CHINA)**	ISO	REMARKS
	Expansion coefficient comparable with austenitic steels									

3. FERROUS METALS - ALLOYED (Cont'd)

3.7 BOLTING (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.7.13	0.25 Mo steel nuts For bolting made from material specified under 3.7.2	+525	A 194 - 2HM	4882: 2HM	-	-	-	40Mn 45	-	
3.7.14	0.25 Mo steel nuts For bolting made from material specified under 3.7.3	+525 (600)	A 194 - 4	4882: 4	-	A 35-557 42 CD 4	-	-	-	
3.7.15	0.25 Mo steel nuts For bolting made from material specified under 3.7.4	-105 +525 (+600) 1)	A 194 - 4,S4	4882: L4	-	-	-	-	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
3.7.16	0.25 Mo steel nuts For bolting made from material specified under 3.7.5	+525	A 194 - 7M,S4	4882: L7M	-	-	-	30CrMoA	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
3.7.17	9 Ni steel nuts For bolting made from material specified under 3.7.6	-200 1)	- -	4882: L9 4882: L9A	- -	- -	- -	- -	- -	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
3.7.18	12 Cr steel nuts For bolting made from material specified under 3.7.7	+425 (+540)	A 194 - 6 1)	4882: 6	17440: X 20 Cr 13	A 35-574 Z 20 C 13	G 4303 SUS 420J2	1Cr13	-	1) Free-machining Grade 6F acceptable, subject to approval of the Principal.
3.7.19	18 Cr-8 Ni steel (strain hardened) nuts For bolting made from material specified under 3.7.8	-200 +815 1)	A 194 - 8,S1 2) 3)	4882: 8X 3)	17440: X 5 CrNi 18 10 3)	A 35-574 Z 6 CN 18-09 3)	G 4303 SUS 304 3)	0Cr18Ni9 3)	-	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC.
3.7.20	18 Cr-8 Ni steel nuts For low-temperature service. For bolting made from material specified under 3.7.11.	-200 1)	A 194 - 8N 3)	4882: 8N 3)	-	-	-	-	-	2) Free-machining Grade 8F acceptable, subject to approval of the Principal. 3) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334.

3. FERROUS METALS - ALLOYED (Cont'd)

3.7 BOLTING (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
3.7.21	18 Cr-8 Ni stabilized steel nuts For bolting made from material specified under 3.7.9	-200 +815 1)	A 194 - 8T 2) 3) A 194 - 8C 2) 3)	4882: 8T 3) 4882: 8C 3)	17440: X 6 CrNiTi 18 10 3) 17440: X 6 CrNiNb 18 10 3)	A 35-574 Z 6 CNT 18-10 3) -	G 4303 SUS 321 3) G 4303 SUS 347 3)	0Cr18Ni10Ti 3)	- -	1) For low-temperature applications, see Appendix 1 and DEP 30.10.02.31-CSPC. 2) Free-machining Grade 8F acceptable, subject to approval of the Principal.
3.7.22	18 Cr-10 Ni-2 Mo steel (strain hardened) nuts For bolting made from material specified under 3.7.10	-200 +500 1)	A 194 - 8M,S1 3)	4882: 8MX 3)	17440: X 5 CrNiMo 17 12 2 3)	A 35-574 Z 7 CND 17-11-02 3)	G 4303 SUS 316 3)	0Cr17Ni12-Mo2 3)	-	3) On completion of solution annealing the material shall be immediately quenched in water, or rapidly cooled by other means, at a rate to prevent reprecipitation of carbides. The material shall be capable of passing the intergranular corrosion test as specified in ASTM A262 Practice E or GB 4334.
3.7.23	Precipitation harden-ing austenitic Ni-Cr steel nuts For bolting made from material specified under 3.7.12	(+540)	A 453-660 Class A	4882: B17B	-	A 35-574 Z 6 NCTDV 25-15 B	G 4311 SUH 660	-	-	

4. NON-FERROUS METALS

4.1 PLATES, SHEETS AND STRIP

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.1.1	Aluminium plates and sheets For certain corrosive conditions	- 200 +200	B 209 - Alloy 1060	1470: 1050A 1)	1745: Al99.5	A 50-451 1050 A	H 4000 A 1050 P	-	209-1/2 Al99.5 6361 - 1/4 Al99.5	Specify annealed condition for all grades. 1) Plates, sheets and strip
4.1.2	Al-2.5Mg alloy plates and sheets For general use under certain corrosive conditions	- 200 +200	B 209 - Alloy 5052	-	1745: AlMg2.5	A 50-451 5052	H 4000 A 5052 P	5A02 (LF2)	209-1/2 AlMg2.5 6361 - 1/4 AlMg2.5	
4.1.3	Al-2.7Mg-Mn alloy plates and sheets For general use under certain corrosive conditions	- 200 +200	B 209 - Alloy 5454	1470: 5454 1)	1745: AlMg2.7Mn	A 50-451 5454	H 4000 A 5454 P	5A02 (LF2)	209-1/2 AlMg3Mn 6361 - 1/4 AlMg3Mn	
4.1.4	Al-4.5Mg-Mn alloy plates and sheets For low temperature applications	- 200 + 65	B 209 - Alloy 5083	1470: 5083 1)	1745: AlMg4.5Mn	A 50-451 5083	H 4000 A 5083 P	-	209-1/2 AlMg4.5Mn0.7 6361 - 1/4 AlMg4.5Mn	
4.1.5	Copper plates, sheets and strip For certain corrosive conditions	- 200 +150	B 152 - C12200	2875: C106 1) 2870: C106 2)	17670: SF-Cu 17675: SF-Cu 1)	A 51-100 Cu-b1	H 3100 C 1220 P	-	1337 - Cu-DHP 1634-1/2 Cu-DHP	Specify annealed condition for all grades. 1) Plates 2) Sheets and strip
4.1.6	Cu-Zn alloy plates and sheets For baffles of coolers and condensers in brackish and seawater service and for general use under certain corrosive conditions	- 200 +175	B 171 - C46400	2875: CZ112 1) 2870: CZ112 2)	17670: CuZn38 Sn1 17675: CuZn39Sn 1)	A51-115 CuZn38 Sn1	H 3100 C 4640 P	-	426- 1CuZn38Sn1 1634-2 CuZn38Sn1	3) Specify Phosphorous 0.015 max.
4.1.7	Cu-Al alloy plates and sheets For tube sheets of coolers and condensers in sweet and brackish water service and for general use under certain corrosive conditions	- 200 +250	B 171 - C61400	2875: CA106 1)	17670: CuAl8Fe3 17675: CuAl8Fe 1)	A51-115 CuAl7 Fe2	H 3100 C 6140 P 3)	-	428 - CuAl8Fe3 1634-2 CuAl8Fe3	

4. NON-FERROUS METALS (Cont'd)

4.1 PLATES, SHEETS AND STRIP (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.1.8	Cu-Al alloy plates and sheets For tube sheets of coolers and condensers in brackish and seawater service and for general use under certain corrosive conditions	- 200 +350	B 171 - C63000 Al content max. 10.0%	2875: CA105 1)	17670: CuAl10Ni5Fe4 17675: CuAl10Ni 1)	A 51-115 CuAl9Ni 5Fe3	H 3100 C 6301 P	-	428 - CuAl10Ni5 Fe4 1634-2 CuAl10Ni5 Fe4	Tube sheets produced by special casting methods from approved manufacturers, are acceptable provided mechanical properties and chemical composition are compatible with this specification. 1) Plates
4.1.9	Cu-Ni (90/10) alloy plates and sheets For tube sheets of coolers and condensers in brackish and seawater service and for general use under certain corrosive conditions	- 200 +350	B 171 - C70600	2875: CN102 1) 2870: CN102 2)	17670: CuNi10Fe1Mn 17675: CuNi10Fe 1)	A51-115 CuNi10Fe 1Mn	H 3100 C 7060 P	-	429 CuNi10Fe1M n 1634-2 CuNi10Fe1 Mn	1) Plates 2) Sheets and strip
4.1.10	Cu-Ni (70/30) alloy plates and sheets For certain corrosive conditions	- 200 +350	B 171 - C71500	2875: CN107 1) 2870: CN107 2)	17670: CuNi30Mn1Fe 17675: CuNi30Fe 1)	A51-115 CuNi30 FeMn	H 3100 C 7150 P	-	429 CuNi30Mn1F e 1634-2 CuNi30Mn 1 Fe	
4.1.11	Nickel plates, sheets and strip For certain corrosive conditions	-200 (+350)	B 162 - N02200	3072: NA11 1) 3073: NA11 2)	17750: Ni99.2	-	H 4551 NNCP	-	-	Specify annealed condition for all grades. 1) Plates and sheet 2) Strip 3) The material shall be capable of passing the Practice C corrosion test as specified in ASTM A262. (Corrosion rate in this test shall not exceed 0.3 mm/year).
4.1.12	Low-carbon nickel plates, sheets and strip For certain corrosive conditions	- 200 +350	B 162 - N02201	3072: NA12 1) 3073: NA12 2)	17750: LC-Ni99	A54-101 Ni02	H 4551 NLCP	-	-	
4.1.13	Ni-Cu alloy (Monel 400) plates, sheets and strip For certain corrosive conditions	- 200 +400	B 127 - N04400	3072: NA13 1) 3073: NA13 2)	17750: NiCu30Fe	-	H 4551 NCuP	-	-	
4.1.14	Ni-Cr-Fe alloy (Inconel 600) plates, sheets and strip For high-temp. conditions and/or certain corrosive conditions	+650	B 168 - N06600	3072: NA14 1) 3073: NA14 2)	17750: NiCr15Fe	-	G 4902 NCF600	-	-	

4. NON-FERROUS METALS (Cont'd)

4.1 PLATES, SHEETS AND STRIP (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.1.15	Ni-Fe-Cr alloy (Incoloy 800) plates, sheets and strip For high-temp. conditions and/or certain corrosive conditions	+815	B 409 - N08800	3072: NA15 1) 3073: NA15 2)	SEW 470: X 10 NiCr AlTi32 20		G 4902 NCF 800	-	-	
4.1.16	Ni-Fe-Cr alloy (Incoloy 800H) plates, sheets and strip For high-temp. conditions and/or certain corrosive conditions	+1000	B 409 - N08810	3072: NA15(H) 1)	-	-	G 4902 NCF 800H	-	-	
4.1.17	Ni-Fe-Cr alloy (Incoloy 800HT) plates, sheets and strip For high-temp. conditions and/or certain corrosive conditions	(+1000)	B 409 - N08811	-	-	-	-	-	-	1) Plates and sheet 2) Strip
4.1.18	Ni-Fe-Cr-Mo-Cu alloy (Incoloy 825) plates, sheets and strip For certain corrosive conditions	+425	B 424 - N08825 3)	3072: NA16 1) 3) 3073: NA16 2) 3)	17750: NiCr21Mo 3)	-	G 4902 NCF 825 3)	-	-	3) The material shall be capable of passing the Practice C intergranular corrosion test as specified in ASTM A262 (Corrosion rate in this test shall not exceed 0.3 mm/year).
4.1.19	Ni-Cr-Mo-Nb alloy (Inconel 625) plates, sheets and strip For certain corrosive conditions	+425	B 443 - N06625	3072: NA21 1) 3073: NA21 2)	17750: NiCr22Mo 9Nb	-	-	-	-	
4.1.20	Ni-Mo alloy (Hastelloy B2) plates, sheets and strip For certain corrosive conditions	+425	B 333 - N10665	-	17750: NiMo28	-	-	-	-	
4.1.21	Ni-Mo-Cr alloy (Hastelloy C4) plates, sheets and strip For certain corrosive conditions	+425	B 575 - N06455	-	17750: NiMo16Cr 16Ti	-	-	-	-	
4.1.22	Ni-Mo-Cr alloy (Hastelloy C276) plates, sheets and strip For certain corrosive conditions	+425 (+650)	B 575 - N10276	-	17750: NiMo16Cr 15W	A54-401 Ni-Mo16 Cr15	-	-	-	
4.1.23	Ni-Cr-Mo alloy (Hastelloy C22) plates, sheets and strip For certain corrosive conditions	(+425)	B 575 - N06022	-	-	-	-	-	-	

4. NON-FERROUS METALS (Cont'd)

4.1 PLATES, SHEETS AND STRIP (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.1.24	Titanium plates, sheets and strip For certain corrosive conditions	(+300)	B 265 - Grade 2 1) 2)	-	17860: Ti2 1) 2)	-	H 4600 TP 35H or C 1) 2)	-	-	1) For linings, tensile properties indicated in the material specifications to be used for information only. Specify soft-annealed material with hardness 140 HV10 max. 2) The softer Grade 1 may also be used for lining.
4.1.25	Tantalum plates, sheets and strip For certain corrosive conditions	2)	B 708 - R05200 1)	-	-	-	H 4701 TaP 1)	-	-	1) For linings, tensile properties indicated in the material specifications to be used for information only. Specify soft-annealed material with hardness 120 HV10 max. 2) Temperature limits depend on nature of services.

4.2 TUBES AND TUBING

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.2.1	Seamless aluminium tubes For unfired heat transfer equipment under certain corrosive conditions	- 200 +200	B 234 - Alloy 1060	1471: 1050A	1795: Al99.5	A 50-411 1050A	H 4080 A 1050 TD	-	209-1/2 Al 99.5 TR2778 Al99.5	Specify annealed condition for all grades.
4.2.2	Seamless Al-2.5 Mg alloy tubes For unfired heat transfer equipment under certain corrosive conditions	- 200 +200	B 234 - Alloy 5052	-	-	A 50-411 5052	H 4080 A 5052 TD	5A02 (LF2)	209-1/2 AlMg 2.5 TR2778 AlMg2.5	
4.2.3	Seamless Al-2.7 Mg- Mn alloy tubes For unfired heat transfer equipment under certain corrosive conditions	- 200 +200	B 234 - Alloy 5454	-	1795: AlMg3	-	-	5A02 (LF2)	209-1/2 AlMg3Mn	
4.2.4	Seamless copper tubing in small sizes For instrument lines	- 200 +150	B 68 - C12200 06 O	2871: Part 2 - C106	17671: SF-Cu	A 51-124 Cu-DHP	H 3300 C 1220	-	1635- Cu DHP	Specify annealed condition for all grades.

4. NON-FERROUS METALS (Cont'd)

4.2 TUBES AND TUBING (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.2.5	Seamless Cu-Zn-Al alloy (Aluminium Brass) tubes For coolers and condensers in brackish and seawater service	(- 200) +175	B 111 - C68700	2871: Part 3 - CZ110	1785: CuZn20Al2 F34	A 51-102 CuZn22 Al2	H 3300 C 6870	-	1635-2 CuZn20Al2	
4.2.6	Seamless copper nickel (90/10 Cu-Ni) alloy tubes For unfired heat transfer equipment under certain corrosive conditions	- 200 +350	B 111 - C70600	2871: Part 3 - CN102	1785: CuNi10Fe 1Mn F29	A 51-102 CuNi10 Fe 1 Mn	H 3300 C 7060	-	1635-2 CuNi10Fe 1Mn	
4.2.7	Seamless copper nickel (70/30 Cu-Ni) alloy tubes For unfired heat transfer equipment under certain corrosive conditions	- 200 +350	B 111 - C71500	2871: Part 3 - CN107	1785: CuNi30Mn 1Fe F37	A 51-102 CuNi30 Mn 1 Fe	H 3300 C 7150	-	1635-2 CuNi30Mn 1Fe	
4.2.8	Seamless copper nickel (66/30/2/2 Cu-Ni-Fe-Mn) alloy tubes. For unfired heat transfer equipment under certain corrosive conditions	- 200 +350	B 111 - C71640	2871: Part 3 - CN108	1785: CuNi30Fe 2Mn 2F42	A 51-102 CuNi30 Fe2 Mn2	H 3300 C 7150	-	1635-2 CuNi30Mn 1Fe	
4.2.9	Seamless nickel tubes For unfired heat transfer equipment under certain corrosive conditions	-200 +350	B 163 - N02200	3074: NA11	17751: Ni99.2 F37	-	-	-	-	Specify solution annealed condition for all grades. For tubes intended for use with compression fittings, hardness shall not exceed 90 HRB.
4.2.10	Seamless low-carbon nickel tubes For unfired heat transfer equipment under certain corrosive conditions	- 200 +350	B 163 - N02201	3074: NA12	17751: LC-Ni99 F34	-	-	-	-	
4.2.11	Seamless Ni-Cu alloy (Monel 400) tubes For unfired heat transfer equipment under certain corrosive conditions	- 200 +400	B 163 - N04400	3074: NA13	17751: NiCu30Fe F45	-	H 4552 NCuT	-	-	
4.2.12	Seamless Ni-Cr-Fe alloy (Inconel 600) tubes For unfired heat transfer equipment under certain corrosive conditions	+650	B 163 - N06600	3074: NA14	17751: NiCr15Fe F50	-	G 4904 NCF 600 TB	-	-	

4. NON-FERROUS METALS (Cont'd)

4.2 TUBES AND TUBING (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.2.13	Seamless Ni-Fe-Cr alloy (Incoloy 800) tubes For unfired heat transfer equipment under certain corrosive conditions	+815	B 163 - N08800	3074: NA15	SEW 470: X 10 NiCr AlTi 32 20	-	G 4904 NCF 800 TB	-	-	
4.2.14	Seamless Ni-Fe-Cr alloy (Incoloy 800H) tubes For furnaces and unfired heat transfer equipment under certain corrosive conditions	+1000	B 407 - N08810	3074: NA15 (H)	-	-	G 4904 NCF 800 HTB	-	-	
4.2.15	Seamless Ni-Fe-Cr alloy (Incoloy 800 HT) tubes For furnaces and unfired heat transfer equipment under certain corrosive conditions	(+1000)	B 407 - N08811	-	-	-	-	-	-	
4.2.16	Seamless Ni-Fe-Cr-Mo-Cu alloy (Incoloy 825) tubes For unfired heat transfer equipment under certain corrosive conditions	(-200) +425	B 163 - N08825	3074: NA16	17751: NiCr21Mo F55	-	G 4904 NCF 825 TB	-		Specify solution annealed condition for all grades. For tubes intended for use with compression fittings, hardness shall not exceed 90 HRB.
4.2.17	Seamless Ni-Cr-Mo-Nb alloy (Inconel 625) tubes For unfired heat transfer equipment under certain corrosive conditions	+425	B 444 - N06625	3074: NA21	17751: NiCr22Mo9Nb F69	-	-	-	-	
4.2.18	Seamless Ni-Mo alloy (Hastelloy B2) tubes For unfired heat transfer equipment under certain corrosive conditions	+425	B 622 - N10665	-	17751: NiMo28			-		
4.2.19	Welded Ni-Mo alloy (Hastelloy B2) tubes For unfired heat transfer equipment under certain corrosive conditions	+425	B 626 - N10665 Class 1A	-	-	-	-	-	-	

4. NON-FERROUS METALS (Cont'd)

4.2 TUBES AND TUBING (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.2.20	Seamless Ni-Mo-Cr alloy (Hastelloy C4) tubes For unfired heat transfer equipment under certain corrosive conditions	+425	B 622 - N06455	-	17751: NiMo16Cr 16Ti	-	-	-	-	
4.2.21	Welded Ni-Mo-Cr alloy (Hastelloy C4) tubes For unfired heat transfer equipment under certain corrosive conditions	+425	B 626 - N06455 Class 1A	-	-	-	-	-	-	
4.2.22	Seamless Ni-Mo-Cr alloy (Hastelloy C276) tubes For unfired heat transfer equipment under certain corrosive conditions	+425 (+650)	B 622 - N10276	-	17751: NiMo16Cr 15W	-	-	-	-	
4.2.23	Welded Ni-Mo-Cr alloy (Hastelloy C276) tubes For unfired heat transfer equipment under certain corrosive conditions	+425 (+650)	B 626 - N10276 Class 1A	-	-	-	-	-	-	
4.2.24	Seamless Ni-Cr-Mo alloy (Hastelloy C22) tubes For unfired heat transfer equipment under certain corrosive conditions	(+425)	B 622 - N06022	-	-	-	-	-	-	
4.2.25	Welded Ni-Cr-Mo alloy (Hastelloy C22) tubes For unfired heat transfer equipment under certain corrosive conditions	(+425)	B 626 - N06022 Class 1A	-	-	-	-	-	-	
4.2.26	Seamless titanium tubes For unfired heat transfer equipment under certain corrosive conditions	(+300)	B 338 - Grade 2	-	17861: Ti2	-	H 4631: TTH 35 D	-	-	
4.2.27	Welded titanium tubes For unfired heat transfer equipment under certain corrosive conditions	(+300)	B 338 - Grade 2	-	17866: Ti2	-	H 4631: TTH 35 WD	-	-	

4. NON-FERROUS METALS (Cont'd)

4.3 PIPE

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.3.1	Seamless aluminium pipe For certain corrosive conditions	- 200 +200	B 241 - Alloy 1060	1474: 1050A	9107: Al99.5	A 50-411 1050A	H 4080 A 1050 TD	-	209-1/2 Al 99.5	Specify annealed condition for all grades.
4.3.2	Seamless Al-Mg-Si alloy pipe For certain corrosive conditions	- 200 +200	B 241 - Alloy 6061	1474: 6061	-	A 50-411 6061	H 4080 A 6061 TD	-	209-1/2 AlMg1SiCu	
4.3.3	Seamless Al-Mg-Si alloy pipe For pipelines under certain corrosive conditions	- 200 +200	B 241 - Alloy 6063	1474: 6063	9107: AlMgSi 0.5	-	H 4080 A 6063 TD	-	209-1/2 AlMg0.7Si	
4.3.4	Seamless Al-2.5Mg alloy pipe For general use under certain corrosive conditions	- 200 +200	B 241 - Alloy 5052	-	-	A 50-411 5052	H 4080 A 5052 TD	5A02 (LF2)	209-1/2 AlMg 2.5	
4.3.5	Seamless Al-2.7Mg-Mn alloy pipe For general use under certain corrosive conditions	- 200 +200	B 241 - Alloy 5454	-	9107: AlMg3	-	-	5A02 (LF2)	209-1/2 AlMg3Mn	
4.3.6	Seamless Al-4.5Mg-Mn alloy pipe For low-temperature service only.	- 200 + 65	B 241 - Alloy 5083	1474: 5083	9107: AlMg4.5Mn	A 50-411 5083	H 4080 A 5083 TD	-	209-1/2 AlMg4.5Mn 0.7	
4.3.7	Seamless copper pipe For certain corrosive conditions	- 200 +150	B 42 - C12200	2871: Part 2 - C106	17671: SF-Cu	A 51-124 Cu/b	H 3300 C1220	-	1635 - Cu-DHP	Specify annealed condition for all grade.
4.3.8	Seamless Cu-Zn-Al alloy (Aluminium Brass) pipe For brackish and seawater service	(-200) +175	B111 C68700	2871: Part 2 - CZ110	17671: CuZn20Al2	-	H 3300 C 6870	-	1635 - CuZn20Al2	
4.3.9	Seamless Cu-Ni alloy (90/10 Cu-Ni) pipe For seawater service	(-200) +350	B 466 - C70600	2871: Part 2 - CN102	17671: CuNi10Fe 1Mn	-	H 3300 C 7060	-	1635 - CuNi10Fe 1Mn	
4.3.10	Seamless Cu-Ni alloy (70/30 Cu-Ni) pipe For certain corrosive conditions	-200 +350	B 466 - C71500	2871: Part 2 - CN107	17671: CuNi30Mn 1Fe	-	H 3300 C 7150	-	1635 - CuNi30Mn 1Fe	

4. NON-FERROUS METALS (Cont'd)

4.3 PIPE (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.3.11	Seamless nickel pipe For certain corrosive conditions	-200 +350	B 161 - N02200	3074: NA11	17751: Ni99.2 F37	-	H 4552 NNCT-0	-	-	Specify cold-worked, annealed and pickled condition for all grades. 1) See DEP 31.24.40.31-CSPC. 2) The material shall be capable of passing the Practice C intergranular corrosion test as specified in ASTM A262. (Corrosion rate in this test shall not exceed 0.3 mm/year).
4.3.12	Seamless low-carbon nickel pipe For certain corrosive conditions	- 200 +350	B 161 - N02201	3074: NA12	17751: LC-Ni99 F34	-	H 4552 NLCT-0	-	-	
4.3.13	Seamless Ni-Cu alloy (Monel 400) pipe For certain corrosive conditions	-200 +400	B 165 - N04400	3074: NA13	17751: NiCu30Fe F45	-	H 4552 NCu T-0	-	-	
4.3.14	Seamless Ni-Cr-Fe alloy (Inconel 600) pipe For high temperature conditions and/or certain corrosive conditions	+650	B 167 - N06600	3074: NA14	17751: NiCr15Fe F50	-	G 4903 NCF 600 TP	-	-	
4.3.15	Seamless Ni-Fe-Cr alloy (Incoloy 800) pipe For high temperature conditions and/or certain corrosive conditions	(-200) +815	B 407 - N08800	3074: NA15	SEW 470: X10NiCr AlTi32 20	-	G 4903 NCF 800 TP	-	-	
4.3.16	Seamless Ni-Fe-Cr alloy (Incoloy 800H) pipe For high temperature conditions and/or certain corrosive conditions	+1000 1)	B 407 - N08810	3074: NA15(H)	-	-	G 4903 NCF 800 HTP	-	-	
4.3.17	Seamless Ni-Fe-Cr alloy (Incoloy 800HT) pipe For high temperature conditions and/or certain corrosive conditions	(+1000) 1)	B 407 - N08811	-	-	-		-	-	
4.3.18	Seamless Ni-Fe-Cr-Mo-Cu alloy (Incoloy 825) pipe For certain corrosive conditions	(-200) +425	B 423 - N08825 2)	3074: NA16 2)	17751: NiCr21Mo F55 2)	-	G 4903 NCF 825 TP 2)	-	-	

4. NON-FERROUS METALS (Cont'd)

4.3 PIPE (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.3.19	Welded Ni-Fe-Cr-Mo-Cu alloy (Incoloy 825) pipe For certain corrosive conditions	(-200) +425	B705 - N08825 Class 2 1)	-	-	-	-	-	-	Specify cold-worked and bright annealed condition. 1) The material shall be capable of passing the Practice C intergranular corrosion test as specified in ASTM A262. (Corrosion rate in this test shall not exceed 0.3 mm/year).
4.3.20	Seamless Ni-Cr-Mo-Nb alloy (Inconel 625) pipe For certain corrosive conditions	+425	B 444 - N06625	3074: NA21	17751: NiCr22Mo 9NbF69	-	-	-	-	Specify cold-worked and bright annealed condition for all grades.
4.3.21	Welded Ni-Cr-Mo-Nb alloy (Inconel 625) pipe For certain corrosive conditions	+425	B705 - N06625 Class 2	-	-	-	-	-	-	Specify cold-worked and bright annealed condition.
4.3.22	Seamless Ni-Mo alloy (Hastelloy B2) pipe For certain corrosive conditions	+425	B 622 - N10665	-	17751: NiMo28	-	-	-	-	
4.3.23	Welded Ni-Mo alloy (Hastelloy B2) pipe For certain corrosive conditions	+425	B 619 - N10665 Class II	-	-	-	-	-	-	
4.3.24	Seamless Ni-Mo-Cr alloy (Hastelloy C4) pipe For certain corrosive conditions	+425	B 622 - N06455	-	17751: NiMo16Cr 16Ti	-	-	-	-	
4.3.25	Welded Ni-Mo-Cr alloy (Hastelloy C4) pipe For certain corrosive conditions	+425	B 619 - N06455 Class II	-	-	-	-	-	-	
4.3.26	Seamless Ni-Mo-Cr alloy (Hastelloy C276) pipe For certain corrosive conditions	+425 (+650)	B 622 - N10276	-	17751: NiMo16Cr 15W	-	-	-	-	

4. NON-FERROUS METALS (Cont'd)

4.3 PIPE (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.3.27	Welded Ni-Mo-Cr alloy (Hastelloy C276) pipe For certain corrosive conditions	+425 (+650)	B 619 - N10276 Class II	-	-	-	-	-	-	
4.3.28	Seamless Ni-Cr-Mo alloy (Hastelloy C22) pipe For certain corrosive conditions	(+425)	B 622 - N06022	-	-	-	-	-	-	
4.3.29	Welded Ni-Cr-Mo alloy (Hastelloy C22) pipe For certain corrosive conditions	(+425)	B 619 N06022 Class II	-	-	-	-	-	-	
4.3.30	Seamless titanium pipe For certain corrosive conditions	(+300)	B 337 - Grade 2	-	17861: Ti2 1)	-	H 4630: TTP 35D 1)	-	-	1) Specify bright annealed condition for seamless and welded.
4.3.31	Welded titanium pipe For certain corrosive conditions	(+300)	B 337 - Grade 2	-	17866: Ti2 1)	-	H4630: TTP 35WD 1)	-	-	

4. NON-FERROUS METALS (Cont'd)

4.4 FORGINGS, FLANGES AND FITTINGS

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.4.1	Al-2.5Mg alloy forgings For general use under certain corrosive conditions	-200 +200	Alloy 5052 1)	-	-	-	-	5A2 (LF2)	209-1/2 AlMg2.5	Specify annealed condition for all grades. 1) Order to ASTM B 247, with reference to ASME VIII, Div. 1, para UG 15. 2) Order to ASTM B 361, with reference to ASME VIII, Div. 1, para UG 15.
4.4.2	Al-2.7Mg-Mn alloy forgings For general use under certain corrosive conditions	-200 +200	Alloy 5454 1)	-	-		-	5A2 (LF2)	209-1/2 AlMg3Mn	
4.4.3	Al-4.5Mg-Mn alloy forgings For low-temperature service only.	-200 + 65	B 247 - Alloy 5083	1472: NF8	1749: AlMg4.5Mn	A50-901 5083	H 4140 A 5083 FD or FH	-	209-1/2 AlMg4.5Mn 0.7	
4.4.4	Al-Mg-Si alloy forgings For certain corrosive conditions and/or low-temperature service.	-200 +200	B 247 - Alloy 6061	-	-	A50-901 6061	H 4140 A 6061 FD or FH	-	209-1/2 AlMg1SiCu	
4.4.5	Al-Mg-Si alloy welding fittings For certain corrosive conditions and/or low-temperature service.	-200 +200	B 361 - WP 6061	-	-	-	-	-	-	
4.4.6	Al-2.5Mg alloy welding fittings For use in marine atmosphere and for general use under certain corrosive conditions	-200 +200	Alloy WP 5052 or WP 5052W 2)	-	-	-	-	-	-	
4.4.7	Al-2.7Mg-Mn alloy welding fittings For use in marine atmosphere and for general use under certain corrosive conditions	-200 +200	Alloy WP 5454 or WP 5454W 2)	-	-	-	-	-	-	
4.4.8	Nickel welding fittings. For certain corrosive conditions	(+325)	B 366 - WPNS or WPNW	-	-	-	-	-	-	
4.4.9	Low-carbon nickel welding fittings For certain corrosive conditions	(+600)	B 366 - WPNLS or WPNLW	-	-	-	-	-	-	
4.4.10	Ni-Cu alloy (Monel 400) forgings. For certain corrosive conditions	-200 +400	B 564 - N04400	-	-	-	-	-	-	

4. NON-FERROUS METALS (Cont'd)

4.4 FORGINGS, FLANGES AND FITTINGS (CONT'D)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.4.11	Ni-Cu alloy (Monel 400) welding fittings For certain corrosive conditions	-200 +400	B 366 - WPNCS or WPNCW	-	17754: NiCu30Fe	-	-	-		Specify solution annealed condition for all grades.
4.4.12	Ni-Cu alloy (Monel) 400) forgings For high temperature conditions and/or certain corrosive conditions	+650	B 564 - N06600	-	-	-	-	-	-	1) See DEP 31.24.40.31-CSPC. 2) The material shall be capable of passing the Practice C intergranular corrosion test as specified in ASTM A262. (Corrosion rate in this test shall not exceed 0.3 mm/year).
4.4.13	Ni-Cr-Fe alloy (Inconel 600) fittings For high temperature conditions and/or certain corrosive conditions	+650	B 366 - WPNC1S or WPNC1W	-	-	-	-	-	-	
4.4.14	Ni-Fe-Cr alloy (Incoloy 800) forgings For extreme temperature service	+815	B 564 - Alloy N08800	-	-	-	-	-	-	
4.4.15	Ni-Fe-Cr alloy (Incoloy 800H) forgings For extreme temperature service	+1000 1)	B 564 - N08810	-	-	-	-	-	-	
4.4.16	Ni-Fe-Cr-Mo-Cu alloy (Incoloy 825) forgings For extreme temperature service	(-200) +450	B 564 - N08825 2)	-	-	-	-	-	-	
4.4.17	Ni-Fe-Cr-Mo-Cu alloy (Incoloy 825) weldng fittings For extreme temperature service	(-200) +450	B 366 - WPNI CMCS or WPNI CMCW 2)	-	-	-	-	-	-	
4.4.18	Ni-Mo alloy (Hastelloy B2) welding fittings For certain corrosive conditions	+425	B 366 - WPHB2S or WPHB2W	-	17754: NiMo30	-	-	-	-	
4.4.19	Ni-Mo-Cr alloy (Hastelloy C4) welding fittings For certain corrosive conditions	+425	B 366 - WPHC4	-	-	-	-	-	-	

4. NON-FERROUS METALS (Cont'd)

4.4 FORGINGS, FLANGES AND FITTINGS (CONT'D)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.4.20	Ni-Mo-Cr alloy (Hastelloy C276) welding fittings For certain corrosive conditions	(+800)	B 366 - WPHC276	-	-	-	-	-	-	
4.4.21	Ni-Cr-Mo alloy (Hastelloy C22) forgings For certain corrosive conditions	(+425)	B 564 - N06022	-	-	-	-	-	-	
4.4.22	Ni-Cr-Mo alloy (Hastelloy C22) welding fittings For certain corrosive conditions	+425	B 366 - WPHC22S or WPHC22W	-	-	-	-	-	-	Specify solution annealed condition for all grades.
4.4.23	Titanium forgings For certain corrosive conditions	(+300)	B 381 - Grade F2	-	17864: Ti2	-	-	-	-	Specify annealed conditon for all grades.
4.4.24	Titanium welding fittings For certain corrosive conditions	(+300)	B 363 - WPT2 or WPT2W	-	-	-	-	-	-	

4. NON-FERROUS METALS (Cont'd)

4.5 CASTINGS

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.5.1	Al-5Si alloy castings For certain corrosive conditions	-200 +200	B 26 - Alloy B443.0 1)	-	-	-	-	-	-	1) Specify B108 Alloy B443.0 for permanent mould castings.
4.5.2	Al-12Si alloy castings For certain corrosive conditions	-200 +200	-	1490: LM6	1725: G-AlSi12	A57-702 A-S13	H 5202 AC3A	-	3522 Al-Si12	
4.5.3	Composition bronze (Bronze 85/5/5/5) castings For flanges, fittings and valves	-200 +175	B 62 - C83600	1400: LG2C	1705: G-CuSn5 ZnPb	A53-707 CuSn5 Pb5Zn5	H 5111 BC6	-	-	1) Lead content 0.3% max.
4.5.4	Tin bronze (Bronze 88/10/2) castings For equipment parts to be used in brackish and seawater service and for certain corrosive conditions	-200 +175	B 584- C90500	1400: G1 1)	1705: G-CuSn10Zn 1)	-	H 5111 BC3	-	-	
4.5.5	Ni-Al bronze castings For equipment parts to be used in brackish and seawater service and for certain corrosive conditions	-200 +350	B 148 - C95800 2)	1400: AB2	1714: G-CuAl10 Ni	A53-709 CuAl10 Fe5Ni5	H 5114 Al BC3	-	-	
4.5.6	Lead in pig form For homogeneous linings of equipment under certain corrosive conditions	+100	B 29 - Chemical - Copper Lead UNS L551121	334: Type A	1719: Pb99.9Cu	A55-105 Pb doux Raffiné 99.90	-	-	-	
4.5.7	Ni-Cu alloy (Monel 400) castings For certain corrosive conditions	-200 +400	A 494 - M35-1	3071: NA1	17730: G-NiCu30 Nb	-	-	-		
4.5.8	Ni-Mo alloy (Hastelloy B2) castings For certain corrosive conditions	+425	A494 - N-7M Class 1	-	-	-	-	-	-	
4.5.9	Ni-Mo-Cr alloy (Hastelloy C4) castings For certain corrosive conditions	+425	A494 - CW-2M	-	-	-	-	-	-	

4. NON-FERROUS METALS (Cont'd)

4.5 CASTINGS (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.5.10	Ni-Mo-Cr alloy (Hastelloy C276) castings For certain corrosive conditions	+425 (+650)	A494 - CW-12MW Class 1	-	-	-	-	-	-	
4.5.11	50Cr-50Ni-Nb alloy castings For furnace tube supports exposed to vanadium attack	+1000	A560 - 50Cr-50Ni-Cb	-	-	-	-	-	-	
4.5.12	Titanium castings For certain corrosive conditions	(+250)	B367 - Grade C2	-	17865: G-Ti2	-	-	-	-	

4. NON-FERROUS METALS (Cont'd)

4.6 BARS, SECTIONS AND WIRE

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.6.1	Extruded aluminium bars, rods, sections (incl. hollow sections), tube and wire For certain corrosive conditions	-200 +200	B 221 - Alloy 1060	1474: 1050A 1)	1747: Al99.5 2)	A50-411 1050A	H 4040 A 1050 BE	-	209-1/2 Al99.5 6362-1/4 Al99.5	For bars, rods and sections, specify annealed condition for all grades. For wire, condition to be agreed upon for each case individually.
4.6.2	Extruded Al-2.5 Mg alloy bars, rods, sections (incl. hollow sections), tube and wire For general use under certain corrosive conditions	-200 +200	B 221 - Alloy 5052	-	-	A 50-702 5052	H 4040 A 5052 BE H 4100 A 5052S 3)	5A02 (LF2)	209-1/2 AlMg2.5	1) Bars, extruded sections (incl. hollow section) and tube. 2) Bars and rods. 3) Extruded sections.
4.6.3	Extruded Al-2.7 Mg-Mn alloy bars, rods, sections (incl. hollow sections), tube and wire For general use under certain corrosive conditions	-200 +200	B 221 - Alloy 5454	-	1747: AlMg3 2)	A 50-411 5454	H 4100 A 5454 S 3)	5A02 (LF2)	209-1/2 AlMg3Mn 6362-1/4 AlMg3Mn	
4.6.4	Extruded Al-Mg-Si alloy bars, rods, sections (incl. hollow sections), tube and wire For general purposes	-200 +200	B 221 - Alloy 6063	1474: 6063 1)	1747: AlMgSi0.5 2)	-	H 4040 A 6063 BE H 4100 A 6063S 3)	-	209-1/2 AlMg0.7Si 6362-1/4 AlMg0.75i	
4.6.5	Copper bars, rods and sections For electrical purposes	-200 +150	B 133 - C11000	2874: C101	40500: SE-Cu	-	H 3250 C 1100 BEC or BED	-	1637 - Cu- ETP	For bars, rods and sections, specify annealed condition for all grades. For wire, condition to be agreed upon foreach case individually.
4.6.6	Copper bars, rods and sections For general purposes	-200 +150	B 133 - C12200	2874: C106	17672: SF-Cu	-	H 3250 C1220 BE or BD	-	1637 - Cu- DHP	
4.6.7	Free cutting Cu-Zn alloy bars, rods and sections For general purposes	-200 +175	B 16 - C36000	2874: CZ124	17672: CuZn36 Pb3	A 51-105 CuZn36 Pb3	H 3250 C 3602 BE or BD	-	1637 - CuZn36 Pb3	
4.6.8	Cu-Zn-Pb alloy bars, rods and sections For general purposes	-200 +150	B140 - C32000 or C31400	-	-	-	-	-	-	

4. NON-FERROUS METALS (Cont'd)

4.6 BARS, SECTIONS AND WIRE (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.6.9	Cu-Al alloy bars, rods and sections For general purposes under certain corrosive conditions	-200 +350	B 150 - C63200	2874: CA104 Al content max. 10.0%	17672: CuAl10Ni 5Fe4	A 51-116 CuAl10Ni5Fe 4	-	-	1637 - CuAl10Ni5 Fe4	
4.6.10	Cu-Ni (90/10) alloy bars, rods and sections For certain corrosive conditions	-200 +350	B 122 - C706	2874: CN102	17672: CuNi10Fe 1Mn	-	-	-	-	
4.6.11	Cu-Ni (70/30) alloy bars, rods and sections For certain corrosive conditions	-200 +350	B 122 - C71500	2874: CN107	17672: CuNi30Mn1Fe	-	-	-	1637 - CuNi30Mn1-Fe	
4.6.12	Phosphor bronze wire For springs	-200 +175	B 159 - C51000 Condition H08 (Spring Temper)	2873: PB102 Condition H	17682: CuSn6F95	A 51-111 CuSn6P	H3270 C5102 W-H	-	1638 - CuSn5	
4.6.13	Nickel bars and rods For certain corrosive conditions	(+325)	B 160 - N02200	3076: NA11	17752: Ni99.2	-	H 4553 NNCB	-	-	For bars and rods, specify solution annealed condition for all grades, except Monel K500 which should be supplied in the solution treated and precipitation hardened condition. For wire, condition to be agreed upon for each case individually. 1) Bar 2) Wire
4.6.14	Low-carbon nickel bars and rods For certain corrosive conditions	-200 +350	B 160 - N02201	3076: NA12	17752: LC-Ni99	-	H 4553 NLCB	-	-	
4.6.15	Ni-Cu alloy (Monel 400) bars, rods and wire For certain corrosive conditions	-200 +400	B 164 - N04400	3076: NA13 1) 3075: NA13 2)	17752: NiCu30Fe	-	H 4553 NCuB	-	-	
4.6.16	Ni-Cu-Al alloy (Monel K500) bars, rods and wire For certain corrosive conditions requiring high tensile strength	-200 +400	-	3076: NA18 1) 3075: NA18 2)	17752: NiCu30Al	-	H 4553 NCu ATB	-	-	
4.6.17	Ni-Cr-Fe alloy (Inconel 600) bars, rods and wire For high-temperature conditions and/or certain corrosive conditions	+650	B 166 - N06600	3076: NA14 1) 3075: NA14 2)	17752: NiCr15Fe	-	G 4901 NCF 600	-	-	
4.6.18	Ni-Cr-Mo-Nb alloy (Inconel 625) bars and rods For certain corrosive conditions	+425	B 446 - N06625	3076: NA21 1)	17752: NiCr22Mo 9Nb	-	-	-	-	

4. NON-FERROUS METALS (Cont'd)

4.6 BARS, SECTIONS AND WIRE (Cont'd)

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.6.19	Ni-Fe-Cr alloy (Incoloy 800) bars, rods and wire For high-temperature conditions and/or certain corrosive conditions	+815	B 408 - N08800	3076: NA15 1) 3075: NA15 2)	SEW 470: X10 NiCr AlTi32 20	-	G 4901 NCF 800	-	-	1) Bar 2) Wire
4.6.20	Ni-Fe-Cr alloy (Incoloy 800H) bars, rods and wire For high-temperature conditions and/or certain corrosive conditions	+1000	B 408 - N08810	3076: NA15(H) 1)	-	-	G 4901 NCF 800H	-	-	
4.6.21	Ni-Fe-Cr alloy (Incoloy 800HT) bars, rods and wire For high-temperature conditions and/or certain corrosive conditions	(+1000)	B 408 - N08811	-	-	-	-	-	-	
4.6.22	Ni-Fe-Cr-Mo-Cu alloy (Incoloy 825) bars, rods and wire For certain corrosive conditions	(+425)	B 425 - N08825	3076: NA16 1)	17752: NiCr21Mo	-	G 4901 NCF 825	-	-	
4.6.23	Ni-Mo alloy (Hastelloy B2) rods For certain corrosive conditions	+425	B 335 - N10665	-	17752: NiMo28	-	H 4553 NM 2B	-	-	
4.6.24	Ni-Mo-Cr alloy (Hastelloy C4) rods For certain corrosive conditions	+425	B 574 - N06455	-	17752: NiMo16Cr 16Ti	-	-	-	-	
4.6.25	Ni-Mo-Cr alloy (Hastelloy C276) rods For certain corrosive conditions	(+800)	B 574 - N10276	-	17752: NiMo16Cr 15W	A54-401 Ni-Mo16 Cr15	H 4553 NM Cr B	-	-	
4.6.26	Ni-Cr-Mo alloy (Hastelloy C22) rods For certain corrosive conditions	(+425)	B 574 - N06022	-	-	-	-	-	-	
4.6.27	Titanium bars For certain corrosive conditions	(+300)	B 348 - Grade 2	-	17862: Ti2	-	H 4650 TB35 H or C	-	-	Specify annealed condition.

4. NON-FERROUS METALS (Cont'd)

4.7 BOLTING

	DESIGNATION AND APPLICATION	Metal Temp., °C (See 1.7)	ASTM	BS	DIN	AFNOR	JIS	GB (CHINA)	ISO	REMARKS
4.7.1	Aluminium alloy bolts and nuts	-200 +200	F467/468 - A96061	-	-	-	-	-	-	Bolting material may also be selected from Section 4.6.
4.7.2	Cu-Al alloy bolts and nuts	-200 +365	F467/468 -C63000	-	-	-	-	-	-	
4.7.3	Cu-Ni (70/30) alloy bolts and nuts	-200 +350	F467/468 -C71500	-	-	-	-	-	-	
4.7.4	Ni-Cu alloy (Monel 400) bolts and nuts	-200 +400	F467/468 - N04400	-	-	-	-	-	-	
4.7.5	Ni-Cu-Al alloy (Monel K500) bolts and nuts	-200 +400	F467/468 - N05500					-		
4.7.6	Ni-Mo alloy (Hastelloy B) bolts and nuts	+425	F467/468 -N10001	-	-	-	-	-	-	
4.7.7	Ni-Mo-Cr alloy (Hastelloy C276) bolts and nuts	(+800)	F467/468 -N10276	-	-	-	-	-		
4.7.8	Titanium bolts and nuts	(+300)	F467/468 -Alloy Ti 2	-	-	-	-	-	-	Bolts primarily intended for use inside equipment.

5. REFERENCES

In this DEP reference is made to the following publications:

NOTES: 1. Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

2. The numerous materials standards found in sections 2 to 4 have not separately been listed here, but the organisation addresses are given.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-CSPC
Metallic Materials - Requirements for prevention of brittle fracture of equipment in low-temperature service (45 °C or below) and equipment containing liquefied gas or lethal substances	DEP 30.10.02.31-CSPC
Selected materials for furnace parts for high-temperature conversion processes	DEP 31 24.40.31-CSPC
Standard vertical tanks - Selection, design and fabrication	DEP 34.51.01.31-CSPC

AMERICAN STANDARDS

Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants — API 941

Issued by:
American Petroleum Institute
Publications and Distribution Section
2101 L Street Northwest
Washington, DC 20037
USA.

ASTM standards

NOTE: Where metric versions of ASTM standards are available (e.g. ASTM A278M) they should be selected. In most cases, ASTM standards and their metric version are issued as a single standard (e.g. ASTM A182/A182M).

Issued by:
American Society for Testing and Materials
1916 Race St., Philadelphia
Pa. 19103, USA.

BRITISH STANDARDS

BSI standards

Issued by:
British Standards Institution
389 Chiswick High Road
London W4 4AL
England
United Kingdom.

EUROPEAN STANDARDS

CEN standards

Issued by:
Committé Européen de Normalisation
Secrétariat Central
Rue de Stassart 36
B-1050 Brussels
Belgium
Copies can also be obtained from national standards organizations

FRENCH STANDARDS

AFNOR standards

Issued by:
AFNOR
Tour Europe
CEDEX 7
92409 Paris La Defense
France

GERMAN STANDARDS

DIN Normen

Issued by:
Beuth Verlag GmbH
Burggrafenstrasse 4-10
1000 Berlin 30, Germany.

SEW Blätter

Issued by:
Verein Deutscher Eisenhüttenleute
Verlag Stahleisen m.b.H
P.O. Box 8229
4-Düsseldorf, Germany.

INTERNATIONAL STANDARDS

ISO standards

Issued by:
International Organization for Standardization
1, Rue de Varembé
CH-1211 Geneva 20
Switzerland.
NOTE: Copies can also be obtained from national standards organizations

PEOPLES' REPUBLIC OF CHINA STANDARDS

Steel Pressure Vessels GB 150

Issued by:
China State Bureau of Technical Supervision
No.4 Zhichun Road
Haidian District
Beijing 100088
People's Republic of China

JAPANESE STANDARDS

JIS standards

Issued by:
Japanese Standards Association
1-24 Akasaka 4 Chome
Minato - ku
Tokyo, Japan.

APPENDIX 1 LOW TEMPERATURE (LT) STEELS FOR USE WITH DEP 30.10.02.31-CSPC

The requirements in this appendix relate to the results of Charpy impact tests on full-size V-notched test pieces (10 mm x 10 mm) tested in accordance with the relevant material specification. The orientation of the Charpy impact specimens (transverse or longitudinal) is optional, unless indicated otherwise in the tables. The minimum specified impact energy is the average of the results of tests made on three test pieces. At most one result may be lower, with a minimum value at least 70% of the specified minimum average value. If sub-size specimens have to be used, the required impact value shall be obtained by multiplying the value specified for full-size specimens by the relevant factor below:

Specimen Size (mm)	Factor
10 x 7.5	0.80
10 x 5.0	0.70

For carbon and carbon-manganese steels, the impact requirements are related to specified minimum tensile strength, as indicated below:

Specified Minimum UTS (N/mm^2)	Required Impact Energy Value at the Material Specification Impact Test Temperature (10 x 10 mm specimen) (Joules)
< 450	≥ 27
≥ 450	≥ 40

Where the material specification specifies a testing temperature different from the standard testing temperatures (0, -20, -30, -40, -50, -60, -80, -100, -120, -196 °C), the LT Number has been obtained by interpolating on the basis of 1.5 Joules per °C. For example, 18 Joules at -51 °C may be regarded as 27 Joules at -45 °C, i.e. LT 40.

Materials supplied in accordance with standards of The People's Republic of China shall additionally meet the impact test requirements of the relevant design and fabrication code (e.g annex C of GB 150)

TABLE 1: PLATES, SHEETS AND STRIP - FINE-GRAINED C-Mn STEEL

STEEL SPECIFICATION			Rm	Charpy V-notch Impact Requirement		LT Number	Remarks
			N/mm2	Joules	°C		
ASTM							
A516	Grade 55, S5		< 450	18	-51	LT40	≤ 25 mm
				18	-51	LT40	25-50 mm
				18	-46	LT40	50-75 mm
				18	-46	LT40	75-125 mm
	Grade 60, S5		< 450	18	-51	LT40	≤ 25 mm
				18	-46	LT40	25-50 mm
				18	-46	LT40	50-75 mm
				18	-46	LT40	75-125 mm
	Grade 65, S5		≥ 450	18	-51	LT30	≤ 25 mm
				18	-46	LT30	25-50 mm
				18	-40	LT20	50-75 mm
				18	-32	LT0	75-125 mm
A 537	Class 1, S5		≥ 450	20	-62	LT30	≤ 25 mm
				20	-60	LT30	25-50 mm
				20	-60	LT30	50-64 mm
	Class 2, S5		≥ 450	20	-60	LT40	64-75 mm
				20	-46	LT30	75-100 mm
A 622	Grade A, S5		< 450	18	-60	LT50	≤ 50 mm
	Grade B, S5		≥ 450	18	-51	LT30	≤ 50 mm
BS							
1501	164	360 LT20	< 450	27	-20	LT20	≤ 63 mm
		400 LT20	< 450	27	-20	LT20	≤ 63 mm
	223	460 LT15	≥ 450	41	-15	LT0	≤ 63 mm
		490 LT15	≥ 450	41	-15	LT0	≤ 63 mm
	224	400 LT50	< 450	27	-50	LT50	≤ 63 mm
		430 LT50	< 450	27	-50	LT50	≤ 63 mm
		460 LT30	≥ 450	41	-30	LT30	≤ 63 mm
		490 LT30	≥ 450	41	-30	LT30	≤ 63 mm
	225	490 LT30	≥ 450	47	-30	LT30	≤ 63 mm

TABLE 1 (CONT'D): PLATES, SHEETS AND STRIP - FINE-GRAINED C-Mn STEEL

STEEL SPECIFICATION		Rm	Charpy V-notch Impact Requirement		LT Number	Remarks
		N/mm2	Joules	°C		
DIN						
17102	TSt E 255	< 450	27	-50	LT50	≤ 150 mm
	ESt E 255	< 450	30	-50	LT50	≤ 150 mm
	TSt E 285	< 450	27	-50	LT50	≤ 150 mm
	ESt E 285	< 450	30	-50	LT50	≤ 150 mm
	TSt E 315	< 450	27	-50	LT50	≤ 150 mm
	ESt E 315	< 450	30	-50	LT50	≤ 150 mm
	TSt E 355	≥ 450	47	-20	LT20	≤ 150 mm
	ESt E 355	≥ 450	40	-40	LT40	≤ 150 mm
	TSt E 380	≥ 450	47	-20	LT20	≤ 150 mm
	ESt E 380	≥ 450	40	-40	LT40	≤ 150 mm
	TSt E 420	≥ 450	47	-20	LT20	≤ 150 mm
	ESt E 420	≥ 450	40	-40	LT40	≤ 150 mm
	TSt E 460	≥450	47	-20	LT20	≤ 150 mm
	ESt E 460	≥ 450	40	-40	LT40	≤ 150 mm
17155	HII	< 450	31	0	LT0	≤ 150 mm
	17 Mn 4	< 450	31	0	LT0	100-150 mm
		≥ 450	31	0	LT0	≤ 100 mm
	19 Mn 6	≥ 450	31	0	LT0	≤ 150 mm
AFNOR						
A36-205	A37 FP	< 450	27	-40	LT40	
	A42 FP	< 450	27	-40	LT40	
	A48 FP	≥ 450	40	-40	LT40	
	A52 FP	≥ 450	40	-40	LT40	
JIS						
G3115	SPV 235	< 450	47	0	LT0	≤ 200 mm
	SPV 315	≥ 450	47	0	LT0	≤ 100 mm
	SPV 355	≥ 450	47	0	LT0	≤ 75 mm

TABLE 1 (CONT'D): PLATES, SHEETS AND STRIP - FINE-GRAINED C-Mn STEEL

STEEL SPECIFICATION		Rm	Charpy V-notch Impact Requirement		LT Number	Remarks
		N/mm2	Joules	°C		
JIS						
G3126	SLA 235A	< 450	Note (1)	-5	LT0	≤ 20 mm
		< 450	Note (1)	-10	LT0	20-50 mm
	SLA 235B	< 450	Note (1)	-15	LT0	≤ 20 mm
		< 450	Note (1)	-30	LT30	20-50 mm
	SLA 325A	< 450	Note (1)	-25	LT20	≤ 20 mm
		< 450	Note (1)	-35	LT30	20-32 mm
	SLA 325B	< 450	Note (1)	-45	LT40	≤ 20 mm
		< 450	Note (1)	-55	LT50	20-32 mm

Note (1) Shall be not less than half of the maximum absorbed energy value.
The maximum absorbed energy shall be expressed as the average value of absorbed energy determined at a temperature at which the percentage brittle fracture of three test pieces becomes zero. This temperature is generally room temperature, but if the percentage brittle fracture of a test piece does not become zero then the test shall be carried out at a higher temperature.

TABLE 2: PLATES, SHEETS AND STRIP - Ni STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy-V notch Impact Requirement Joules	°C	LT Number	Remarks
ASTM						
A203	D, S5	≥ 450	18	-101	LT80	≤ 50 mm
			18	-87	LT80	50-75 mm
	E, S5	≥ 450	20	-101	LT80	≤ 50 mm
			20	-87	LT80	50-75 mm
A645, S64		≥ 450	34	-170	LT120	≤ 50 mm
A353, S55 and S56		≥ 450	S55, 70 (*)	-196	LT196	≤ 50 mm
			S56, 40 (*)	-196		
A553	Type I, S55 & S56	≥ 450	S55, 80 (*)	-196	LT196	≤ 50 mm
			S56, 50 (*)	-196		
BS						
1501	503	≥ 450	27	-100	LT100	≤ 50 mm
	510	≥ 450	54	-196	LT196	≤ 50 mm
	510N	≥ 450	54	-196	LT196	≤ 50 mm
DIN						
17280	11 Mn Ni 5 3	< 450	40	-60	LT60	≤ 70 mm
	13 Mn Ni 6 3	≥ 450	40	-60	LT60	≤ 70 mm
	14 Ni Mn 6	≥ 450	40	-80	LT80	≤ 30 mm
			40	-70	LT80	30-50 mm
	10 Ni 14	≥ 450	40	-100	LT100	≤ 30 mm
			40	-90	LT80	30-50 mm
			40	-85	LT80	50-70 mm
	12 Ni 19	≥ 450	40	-120	LT120	≤ 30 mm
			40	-110	LT100	30-50 mm
	X 8 Ni 9	≥ 450	40	-196	LT196	≤ 70 mm
AFNOR						
A36-208	0.5 Ni 285	< 450	40	-60	LT60	≤ 70 mm
	355	≥ 450	40	-60	LT60	≤ 70 mm
	1.5 Ni 285	≥ 450	40	-80	LT80	≤ 70 mm
	355	≥ 450	40	-80	LT80	≤ 70 mm
	3.5 Ni 285	≥ 450	40	-100	LT100	≤ 70 mm
	355	≥ 450	40	-100	LT100	≤ 70 mm
	5 Ni 390	≥ 450	40	-120	LT120	≤ 70 mm
	9 Ni 490	≥ 450	40	-196	LT196	≤ 50 mm
	585	≥ 450	40	-196	LT196	≤ 50 mm

NOTE: (*) 0.50 mm lateral expansion minimum.

TABLE 2 (CONT'D): PLATES, SHEETS AND STRIP - Ni STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement Joules	°C	LT Number	Remarks
JIS						
G3127	SL3N255	≥ 450	21	-101	LT80	≤ 50 mm
	SL3N275	≥ 450	21	-101	LT80	≤ 50 mm
	SL3N440	≥ 450	27	-110	LT100	≤ 50 mm
	SL5N590	≥ 450	41	-130	LT120	≤ 50 mm
	SL9N520	≥ 450	34	-196	LT196	≤ 50 mm
	SL9N590	≥ 450	41	-196	LT196	≤ 50 mm

TABLE 3: PLATES, SHEETS AND STRIP - AUSTENITIC STAINLESS STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement		LT Number	Remarks
			Joules	°C		
ASTM						
A240	Type 304		-	-	LT196	
	304N		-	-	LT196	
	304L		-	-	LT196	
	316		-	-	LT196	
	316L		-	-	LT196	
	S31803 (Note 1)		40	-30	LT30	
	S32750 (Note 1)		40	-30	LT30	
	S31254		-	-	LT196	
BS						
1501	304 S31		-	-	LT196	
	304 S11		-	-	LT196	
	316 S31		-	-	LT196	
	316 S11		-	-	LT196	
	318 S13 (Note 1)		40	-30	LT30	
SEW						
400	X2CrNiMoN 22 5 3 (Note 1)		40	-30	LT30	
DIN						
17440	X 5 Cr Ni 18 10		-	-	LT196	
	X 2 Cr Ni 19 11		-	-	LT196	
	X 5 Cr Ni Mo 17 12 2		-	-	LT196	
	X 2 Cr Ni Mo 17 13 2		-	-	LT196	
AFNOR						
A36-209	Z7 CN 18-09		-	-	LT196	
	Z6 CN 18-09 Az		-	-	LT196	
	Z3 CN 18-10		-	-	LT196	
	Z7 CND 17-11-02		-	-	LT196	
	Z3 CND 17-11-02		-	-	LT196	
	Z3 CND 22-05 Az (Note 1)		40	-30	LT30	
	Z3 CND 25-07 Az (Note 1)		40	-30	LT30	
JIS						
G4304	SUS 304		-	-	LT196	
	SUS 304N1		-	-	LT196	
	SUS 304L		-	-	LT196	
	SUS 316		-	-	LT196	
	SUS 316L		-	-	LT196	
	SUS 329J2L (Note 1)		40	-30	LT30	

Note (1) Duplex Stainless Steel (Note that the Charpy V-notch requirement is supplementary to standard material specification).

TABLE 4: TUBES AND TUBING - FINE-GRAINED C-Mn STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement		LT Number	Remarks
			Joules	°C		
ASTM						
A179		< 450	-	-	-	Note (1)
A334	Grade 6	< 450	18	-45	LT30	
BS						
3606	CFS 320	< 450	-	-	-	Note (1)
3603	CFS 430 LT Cat. 2	< 450	27	-50	LT50	≤ 25 mm
DIN						
17175	St 35.8	< 450	-	-	-	Note (1)
	St 45.8	< 450	-	-	-	Note (1)
17173	TT St 35 N	< 450	40	-40	LT40	≤ 10 mm
	TT St 35 V	< 450	40	-50	LT50	≤ 25 mm
			40	-40	LT40	25-40 mm
AFNOR						
A49-210	TU 37-B	< 450	-	-	-	Note (1)
A49-213	TU 37-C	< 450	-	-	-	Note (1)
A49-215	TU 37-C	< 450	-	-	-	Note (1)
A49-215	TU 42 BT	< 450	28	-45	LT40	
A49-230	TU 42 BT	< 450	28	-45	LT40	
JIS						
G3461	STB 340	< 450	-	-	-	Note (1)
G3464	STBL 380	< 450	21	-45	LT40	

Note (1) Refer to DEP 30.10.02.31-CSPC

TABLE 5: TUBES AND TUBING - Ni STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement Joules	°C	LT Number	Remarks
BS						
3603	CFS 503 LT Cat. 2	< 450	27	-100	LT100	
	CFS 509 LT Cat. 2	≥ 450	40	-196	LT196	
DIN						
17173	11 Mn Ni 5 3	< 450	40	-60	LT60	
	13 Mn Ni 6 3	≥ 450	40	-60	LT60	
	10 Ni 14	≥ 450	40	-100	LT100	≤ 25 mm
			40	-90	LT80	25-40 mm
	12 Ni 19	≥ 450	40	-120	LT120	≤ 25 mm
			40	-110	LT100	25-40 mm
	X 8 Ni 9	≥ 450	40	-196	LT196	
AFNOR						
A49-230	TU 17 N2	> 450	40	-60	LT60	
	TU 10 N9	≥ 450	40	-90	LT80	
	TU 10 N14	≥ 450	40	-100	LT100	
	TU Z6 N9	> 450	50	-196	LT196	
JIS						
G3464	STBL 450	≥ 450	21	-100	LT80	
	STBL 690	≥ 450	21	-196	LT120	

TABLE 6: TUBES AND TUBING - AUSTENITIC STAINLESS STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement Joules	°C	LT Number	Remarks
ASTM						
A249	Type 304		-	-	LT196	
	304L		-	-	LT196	
	316		-	-	LT196	
	316L		-	-	LT196	
A213	Type 304		-	-	LT196	
	304L		-	-	LT196	
	316		-	-	LT196	
	316L		-	-	LT196	
BS						
3605	LWHT 304 S31		-	-	LT196	
	LWHT 304 S11		-	-	LT196	
	LWHT 316 S31		-	-	LT196	
	LWHT 316 S11		-	-	LT196	
3606	LWHT 304 S31		-	-	LT196	
	LWHT 304 S11		-	-	LT196	
	LWHT 316 S31		-	-	LT196	
	LWHT 316 S11		-	-	LT196	
	CFS 304 S31		-	-	LT196	
	CFS 304 S11		-	-	LT196	
	CFS 316 S31		-	-	LT196	
	CFS 316 S11		-	-	LT196	
DIN						
17457	X5 Cr Ni 18 10		-	-	LT196	
	X2 Cr Ni 19 11		-	-	LT196	
	X5 Cr Ni Mo 17 12 2		-	-	LT196	
	X2 Cr Ni Mo 17 13 2		-	-	LT196	
17458	X5 Cr Ni 18 10		-	-	LT196	
	X2 Cr Ni 19 11		-	-	LT196	
	X5 Cr Ni Mo 17 12 2		-	-	LT196	
	X2 Cr Ni Mo 17 13 2		-	-	LT196	
AFNOR						
A49-217	TUZ6 CN 18-09		-	-	LT196	
	TUZ2 CN 18-10		-	-	LT196	
	TUZ6 CND 17-11		-	-	LT196	
	TUZ2 CND 17-12		-	-	LT196	

TABLE 6 (CONT'D): TUBES AND TUBING - AUSTENITIC STAINLESS STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement		LT Number	Remarks
			Joules	°C		
AFNOR						
A49-214	GRADE DESIGNATION EQUIVALENT TO 304		-	-	LT196	
	GRADE DESIGNATION EQUIVALENT TO 304L		-	-	LT196	
	GRADE DESIGNATION EQUIVALENT TO 316		-	-	LT196	
	GRADE DESIGNATION EQUIVALENT TO 316L		-	-	LT196	
A49-230	TUZ6 CN 19-10		-	-	LT196	
	TUZ2 CN 19-11		-	-	LT196	
	TUZ6 CND 17-12		-	-	LT196	
	TUZ2 CND 17-12		-	-	LT196	
JIS						
G3463	SUS 304TB		-	-	LT196	Note (1)
	SUS 304LTB		-	-	LT196	Note (1)
	SUS 316TB		-	-	LT196	Note (1)
	SUS 316LTB		-	-	LT196	Note (1)

Note (1) Seamless and welded.

TABLE 7: PIPE - FINE-GRAINED C-Mn STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement Joules	°C	LT Number	Remarks
ASTM						
A333	Grade 6	< 450	18	-45	LT30	
A671	Grade CC65 Class 32, S2	≥ 450	18	-51	LT30	≤ 25 mm
			18	-46	LT30	25-50 mm
			18	-40	LT20	50-75 mm
			18	-32	LT0	75-125 mm
BS						
3603	HFS 430 LT Cat. 2	< 450	27	-50	LT50	≤ 25 mm
DIN						
17173	TT St 35 N	< 450	40	-40	LT40	≤ 10 mm
	TT St 35 V	< 450	40	-50	LT50	≤ 25 mm
			40	-40	LT40	25-40 mm
AFNOR						
A49-230	TU 42 BT	< 450	28	-45	LT40	
JIS						
G3460	STPL 380	< 450	21	-45	LT40	

TABLE 8: PIPE - Ni STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement Joules	°C	LT Number	Remarks
ASTM						
A333	Grade 3	≥ 450	18	-100	LT80	
	Grade 8	≥ 450	Note (1)	-196	LT196	
BS						
3603	HFS 503 LT Cat. 2	< 450	27	-100	LT100	
	HFS 509 LT Cat. 2	≥ 450	40	-196	LT196	
DIN						
17173	11 Mn Ni 5 3	< 450	40	-60	LT60	
	13 Mn Ni 6 3	≥ 450	40	-60	LT60	
	10 Ni 14	≥ 450	40	-100	LT100	≤ 25 mm
			40	-90	LT80	25-40 mm
	12 Ni 19	≥ 450	40	-120	LT120	≤ 25 mm
			40	-110	LT100	25-40 mm
	X 8 Ni 9	≥ 450	40	-196	LT196	
AFNOR						
A49-230	TU 27 N2	> 450	40	-60	LT60	
	TU 10 N9	≥ 450	40	-80	LT80	
	TU 10 N14	≥ 450	40	-100	LT100	
	TU Z6 N9	> 450	50	-196	LT196	
JIS						
G3460	STPL 450	≥ 450	21	-100	LT80	
	STPL 690	≥ 450	21	-196	LT120	

Note (1) 0.38 mm lateral expansion minimum.

TABLE 9: PIPE - AUSTENITIC STAINLESS STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement Joules	°C	LT Number	Remarks
ASTM						
A312	Type 304		-	-	LT196	
	304L		-	-	LT196	
	316		-	-	LT196	
	316L		-	-	LT196	
	S31254		-	-	LT196	
A358	Type 304 Class 1		-	-	LT196	
	316 Class 1		-	-	LT196	
A790	S31803 (Note 1)		40	-30	LT30	
	S32750 (Note 1)		40	-30	LT30	
BS						
3605	CFS 304 S31		-	-	LT196	
	CFS 304 S11		-	-	LT196	
	CFS 316 S31		-	-	LT196	
	CFS 316 S11		-	-	LT196	
	LWHT 304 S31		-	-	LT196	
	LWHT 304 S11		-	-	LT196	
	LWHT 316 S31		-	-	LT196	
	LWHT 316 S11		-	-	LT196	
DIN						
17457	X5 Cr Ni 18 10		-	-	LT196	
	X2 Cr Ni 19 11		-	-	LT196	
	X5 Cr Ni Mo 17 12 2		-	-	LT196	
	X2 Cr Ni Mo 17 13 2		-	-	LT196	
17458	X5 Cr Ni 18 10		-	-	LT196	
	X2 Cr Ni 19 11		-	-	LT196	
	X5 Cr Ni Mo 17 12 2		-	-	LT196	
	X2 Cr Ni Mo 17 13 2		-	-	LT196	
AFNOR						
A49-230	TUZ6 CN 19-10		-	-	LT196	
	TUZ2 CN 19-11		-	-	LT196	
	TUZ6 CND 17-12		-	-	LT196	
	TUZ2 CND 17-12		-	-	LT196	
JIS						
G3459	SUS 304TP		-	-	LT196	
	SUS 304LTP		-	-	LT196	
	SUS 316TP		-	-	LT196	
	SUS 316LTP		-	-	LT196	
	SUS 329J2LTP (Note 1)		40	-30	LT30	

Note (1) Duplex stainless steel (Note that the Charpy V-notch requirement is supplementary to the standard material specification).

TABLE 10: FORGINGS, FLANGES AND FITTINGS - FINE-GRAINED C-Mn STEEL

STEEL SPECIFICATION			Rm N/mm2	Charpy V-notch Impact Requirement Joules	°C	LT Number	Remarks
ASTM							
A350	LF2		≥ 450	20	-45.6	LT30	
A420	WPL6 + WPL6W		< 450	17.6	-45	LT30	
A765	Grade II		≥ 450	20	-45	LT30	
BS							
1503	223-410	LT10	< 450	27	-10	LT0	No limit
		LT20		27	-20	LT20	≤ 150 mm
		LT50		27	-50	LT50	≤ 100 mm
	223-430	LT10	< 450	27	-10	LT0	No limit
		LT15		27	-15	LT0	≤ 150 mm
		LT40		27	-40	LT40	≤ 100 mm
	223-460	LT0	≥ 450	41	0	LT0	No limit
		LT10		41	-10	LT0	≤ 150 mm
		LT20		41	-20	LT20	≤ 100 mm
	223-490	LT0	≥ 450	41	0	LT0	≤ 150 mm
		LT10		41	-10	LT0	≤ 100 mm
	223-510	LT0	≥ 450	41	0	LT0	≤ 150 mm
	224-410	LT10	< 450	27	-10	LT0	No limit
		LT20		27	-20	LT20	≤ 150 mm
		LT50		27	-50	LT50	≤ 100 mm
	224-430	LT10	< 450	27	-10	LT0	No limit
		LT15		27	-15	LT0	≤ 150 mm
		LT40		27	-40	LT40	≤ 100 mm
	224-460	LT0	≥ 450	41	0	LT0	No limit
		LT10		41	-10	LT0	≤ 150 mm
		LT20		41	-20	LT20	≤ 100 mm
	224-490	LT0	≥ 450	41	0	LT0	≤ 150 mm
		LT10		41	-10	LT0	≤ 100 mm
	224-510	LT0	≥ 450	41	0	LT0	≤ 150 mm
1640	WPL 0		< 450	21	-50	LT40	
JIS							
G3205	SFL 2		≥ 450	27	-45	LT30	

TABLE 11: FORGINGS, FLANGES AND FITTINGS - Ni STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement Joules	°C	LT Number	Remarks
ASTM						
A420	WPL 3 + WPL3W	≥ 450	17.6	-100	LT80	
	WPL 8 + WPL8W	≥ 450	33.9	-196	LT196	
A350	LF 3	≥ 450	20	-101	LT80	
A522	Type I (NNT)	≥ 450	L 70 (*)	-196	LT196	≤ 75 mm
			T 40 (*)	-196		
	Type I (QT)	≥ 450	L 80 (*)	-196	LT196	≤ 125 mm
			T 50 (*)	-196		
BS						
1640	WPL 3	≥ 450	21	-100	LT80	
1503	503-490	≥ 450	27	-80	LT80	≤ 150 mm
	509-690	≥ 450	34	-196	LT196	≤ 150 mm
DIN						
17280	11 Mn Ni 5 3	< 450	40	-60	LT60	≤ 70 mm
	13 Mn Ni 6.3	≥ 450	40	-60	LT60	≤ 70 mm
	14 Ni Mn 6	≥ 450	40	-80	LT80	≤ 30 mm
			40	-70	LT60	30-50 mm
	10 Ni 14	≥ 450	40	-100	LT100	≤ 30 mm
			40	-90	LT80	30-50 mm
			40	-85	LT80	50-70 mm
	12 Ni 19	≥ 450	40	-120	LT120	≤ 30 mm
			40	-110	LT100	30-50 mm
	X 8 Ni 9	≥ 450	40	-196	LT196	≤ 70 mm
JIS						
G3205	SFL 3	≥ 450	27	-101	LT100	

NOTE (*) 0.50 mm lateral expansion minimum
where L = Longitudinal axis of specimen oriented parallel to major direction of grain flow.
and T = Longitudinal axis of specimen oriented transverse to major direction of grain flow.
(Testing to be carried out in **both** directions)

TABLE 12: FORGINGS, FLANGES AND FITTINGS - AUSTENITIC STAINLESS STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement		LT Number	Remarks
			Joules	°C		
ASTM						
A403	WP 304		-	-	LT196	
	WP 304L		-	-	LT196	
	WP 316		-	-	LT196	
	WP 316L		-	-	LT196	
	WP S31254		-	-	LT 196	
A815	S31803 (Note 1) Class WP-S or WP-WK		40	-30	LT30	
A182	F 304		-	-	LT196	
	F 304L		-	-	LT196	
	F 316		-	-	LT196	
	F 316L		-	-	LT196	
	F 44		-	-	LT196	
	F 51 (Note 1)		40	-30	LT30	
	F 53 (Note 1)		40	-30	LT30	
BS						
1640	WP 304		-	-	LT196	
	WP 304L		-	-	LT196	
	WP 316		-	-	LT196	
	WP 316L		-	-	LT196	
1503	304 S31		-	-	LT196	
	304 S11		-	-	LT196	
	316 S31		-	-	LT196	
	316 S11		-	-	LT196	
	318 S13 (Note 1)		40	-30	LT30	
970	304 S31		-	-	LT196	
	304 S11		-	-	LT196	
	316 S31		-	-	LT196	
	316 S11		-	-	LT196	
SEW						
400	X2CrNiMoN 225 3 (Note 1)		40	-30	LT30	
DIN						
17440	X5 Cr Ni 18 10		-	-	LT196	
	X2 Cr Ni 19 11		-	-	LT196	
	X5 Cr Ni Mo 17 12 2		-	-	LT196	
	X2 Cr Ni Mo 17 13 2		-	-	LT196	

Note (1) Duplex stainless steel (Note that the Charpy V-notch requirement is supplementary to standard material specification).

TABLE 12 (CONT'd): FORGINGS, FLANGES AND FITTINGS - AUSTENITIC STAINLESS STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement		LT Number	Remarks
			Joules	°C		
AFNOR						
A36-607	Z6 CN 18-09		-	-	LT196	
	Z2 CN 18-10		-	-	LT196	
	Z6 CND 17-11		-	-	LT196	
	Z2 CND 17-12		-	-	LT196	
JIS						
G3214	SUS F304		-	-	LT196	
	SUS F304L		-	-	LT196	
	SUS F316		-	-	LT196	
	SUS F316L		-	-	LT196	

TABLE 13: CASTINGS - FINE-GRAINED C-Mn STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement Joules	°C	LT Number	Remarks
ASTM						
A352	LCA	< 450	18	-32	LT20	
	LCB	≥ 450	18	-46	LT30	
	LCC	≥ 450	20	-46	LT30	
BS						
1504	161-430A LT40	< 450	20	-40	LT30	
SEW						
685	GS-21 Mn 5 N	≥ 450	27	-30	LT20	≤ 30 mm
	GS-21 Mn 5	≥ 450	35	-50	LT40	≤ 100 mm
AFNOR						
A32-055	A420 FP-M	≤ 450	22	-40	LT30	
	A480 FP-M	> 450	24	-40	LT30	
JIS						
G5152	SCPL 1	≥ 450	18	-45	LT30	

TABLE 14: CASTINGS - Ni STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement		LT Number	Remarks
			Joules	°C		
ASTM						
A352	LC 3	≥ 450	20	-101	LT80	
	LC 9	≥ 450	27	-196	LT196	
A571	D-2M Class 1 (Note 1)	-	21	-196	LT100	
	Class 2 (Note 1)	-	27	-196	LT100	
BS						
1504	503 LT60	≥ 450	20	-60	LT40	
3468	S2M (Note 1)	-	15	-150	LT100	
SEW						
685	GS-10 Ni 6	< 450	27	-50	LT50	
	GS-10 Ni 14	≥ 450	27	-90	LT80	
DIN						
1694	GGG-Ni Mn 23 4 (Note 1)	< 450	24	-196	LT100	
AFNOR						
A32-053	FC3-M	≤ 450	22	-40	LT30	
A32-055	20N12-M	> 450	24	-40	LT30	
A32-301	S-NM 23 4 (Note 1)	< 450	27	-100	LT100	
JIS						
G3152	SCPL 31	≥ 450	21	-100	LT80	

Note (1) Austenitic ductile Iron

TABLE 15: CASTINGS - AUSTENITIC STAINLESS STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement		LT Number	Remarks
			Joules	°C		
ASTM						
A351	CF8		-	-	LT196	
	CF8M		-	-	LT196	
A744	CF8		-	-	LT196	
	CF8M		-	-	LT196	
BS						
1504	304 C15 LT196		41	-196	LT196	
	316 C16 LT196		41	-196	LT196	
3100	304 C15		41	-196	LT196	
	316 C16		41	-196	LT196	
DIN						
17445	G-X 6 Cr Ni 18 9		-	-	LT196	
	G-X 6 Cr Ni Mo 18 10		-	-	LT196	
AFNOR						
A32-056	Z6 CN 18-10-M		-	-	LT196	
	Z6 CND 18-12-M		-	-	LT196	
JIS						
G5121	SCS 13A		-	-	LT196	
	SCS 14A		-	-	LT196	

TABLE 16: BARS, SECTIONS AND WIRE - FINE-GRAINED C-Mn STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement		LT Number	Remarks
			Joules	°C		
BS						
1502	211 LT0	< 450	27	0	LT0	
	221 LT0	< 450	27	0	LT0	
	224 430 LT50	< 450	27	-50	LT50	
	224 490 LT30	≥ 450	41	-30	LT30	
DIN						
17102	TSt E 255	< 450	27	-50	LT50	≤ 150 mm
	ESt E 255	< 450	30	-50	LT50	≤ 150 mm
	TSt E 285	< 450	27	-50	LT50	≤ 150 mm
	ESt E 285	< 450	30	-50	LT50	≤ 150 mm
	TSt E 315	< 450	27	-50	LT50	≤ 150 mm
	ESt E 315	< 450	30	-50	LT50	≤ 150 mm
	TSt E 355	≥ 450	47	-20	LT20	≤ 150 mm
	ESt E 355	≥ 450	40	-40	LT40	≤ 150 mm
	TSt E 380	≥ 450	47	-20	LT20	≤ 150 mm
	ESt E 380	≥ 450	40	-40	LT40	≤ 150 mm
	TSt E 420	≥ 450	47	-20	LT20	≤ 150 mm
	ESt E 420	≥ 450	40	-40	LT40	≤ 150 mm
	TSt E 460	≥ 450	47	-20	LT20	≤ 150 mm
	ESt E 460	≥ 450	40	-40	LT40	≤ 150 mm
	TSt E 500	≥ 450	47	-20	LT20	≤ 150 mm
	ESt E 500	≥ 450	40	-40	LT40	≤ 150 mm

TABLE 17: BARS, SECTIONS AND WIRE - Ni STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement Joules	°C	LT Number	Remarks
BS						
1502	509-650	≥ 450	42	-196	LT196	
	509-690	≥ 450	27	-196	LT196	
DIN						
17280	11 Mn Ni 5 3	< 450	40	-60	LT60	
	13 Mn Ni 6 3	≥ 450	40	-60	LT60	
	14 Ni Mn 6	≥ 450	40	-80	LT80	≤ 30 mm
			40	-70	LT60	30-50 mm
	10 Ni 14	≥450	40	-100	LT100	≤ 30 mm
			40	-90	LT80	30-50 mm
			40	-80	LT80	50-70 mm
	12 Ni 19	≥450	40	-120	LT120	≤ 30 mm
			40	-110	LT100	30-50 mm
	X 8 Ni 9	≥450	40	-196	LT196	

TABLE 18: BARS, SECTIONS AND WIRE - AUSTENITIC STAINLESS STEEL

STEEL SPECIFICATION		Rm N/mm2	Charpy V-notch Impact Requirement		LT Number	Remarks
			Joules	°C		
ASTM						
A276	S 31254		-	-	LT196	
A479	Type 304		-	-	LT196	
	Type 304L		-	-	LT196	
	Type 316		-	-	LT196	
	Type 316L		-	-	LT196	
	S 31803 (Note 1)		40	-30	LT30	
	S 32750 (Note 1)		40	-30	LT30	
A313	Type 302		-	-	LT196	
BS						
970	304 S15		-	-	LT196	
	316 S31		-	-	LT196	
1502	304 S11		-	-	LT196	
	304 S31		-	-	LT196	
	316 S11		-	-	LT196	
	316 S31		-	-	LT196	
2056	302 S26		-	-	LT196	
DIN						
17440	X 5 Cr Ni 18 10		-	-	LT196	
	X 2 Cr Ni 19 11		-	-	LT196	
	X 5 Cr Ni Mo 17 12 2		-	-	LT196	
	X 2 Cr Ni Mo 17 13 2		-	-	LT196	
17224	X 12 Cr Ni 17 7		-	-	LT196	
AFNOR						
A35-574	Z6 CN 18-09		-	-	LT196	
	Z7 CND 17-11-02		-	-	LT196	
	Z12 CN 18-09		-	-	LT196	
JIS						
G4303	SUS 304		-	-	LT196	
	SUS 316		-	-	LT196	
G4314	SUS 302		-	-	LT196	

Note (1) Duplex stainless steel (Note that the Charpy V-notch requirement is supplementary to standard material specification).

TABLE 19: BOLTING

STEEL SPECIFICATON					Charpy-V notch Impact Requirement		Minimum Allowable Lower Design Temperature	Remarks
BOLTS			NUTS		Joules	°C	°C	
ASTM								
A193	B7		A194	2H	-	-	-30	≤ 40 mm dia.
	B7M			2HM	-	-	-30	≤ 40 mm dia.
	B8	Class 1		8	-	-	-200	
	B8	Class 2		8,S1	-	-	-200	
	B8T	Class 1		8T	-	-	-200	
	B8T	Class 2		8T,S1	-	-	-200	
	B8C	Class 1		8C	-	-	-200	
	B8C	Class 2		8C,S1	-	-	-200	
	B8M	Class 1		8M	-	-	-200	
	B8M	Class 2		8M,S1	-	-	-200	
	B8N	Class 1		8N	-	-	-200	
	B8N	Class 2		8N,S1	-	-	-200	
A320	L7		A194	4,S4	27	-101	-105	
	L7M			7M,S4	27	-73	-80	
	B8	Class 1		8	-	-	-200	
	B8	Class 2		8,S1	-	-	-200	
	B8T	Class 1		8T	-	-	-200	
	B8T	Class 2		8T,S1	-	-	-200	
	B8C	Class 1		8C	-	-	-200	
	B8C	Class 2		8C,S1	-	-	-200	
	B8M	Class 1		8M	-	-	-200	
	B8M	Class 2		8M,S1	-	-	-200	
	B8N	Class 1		8N	-	-	-200	
	B8N	Class 2		8N,S1	-	-	-200	
BS								
4882	B7		4882	2H	-	-	-30	≤ 40 mm dia.
	B7M			2HM	-	-	-30	≤ 40 mm dia.
	L7			L4	27	-100	-105	
	L7M			L7M	27	-100	-105	
	L9			L9	40	-196	-200	
	L9A			L9A	40	-196	-200	
	B8			8	-	-	-200	
	B8X			8X	-	-	-200	
	B8T			8T	-	-	-200	
	B8C			8C	-	-	-200	
	B8M			8M	-	-	-200	
	B8MX			8MX	-	-	-200	
	B8N			8N	-	-	-200	

TABLE 19: BOLTING (CONT'D)

STEEL SPECIFICATION		Charpy V-notch Impact Requirement		Minimum Allowable Lower Design Temperature	Remarks
BOLTS	NUTS	Joules	°C	°C	
DIN					
17200:	17200:				
42 Cr Mo 4	C45	-	-	-30	≤ 40 mm dia.
17440:	17440:				
X 5 CrNi 18 10	X 5 CrNi18 10	-	-	-200	
X 6 CrNiTi 18 10	X 6 CrNiTi 18 10	-	-	-200	
X 6 CrNiNb 18 10	X 6 CrNiNb 18 10	-	-	-200	
X 5 CrNiMo 17 12 2	X 5 CrNiMo 17 12 2	-	-	-200	
AFNOR					
A35-557 42 CD 4	A35-557 XC 38	-	-	-30	≤ 40 mm dia.
A35-559 42 CD 4	A35-559 42 CD 4	28	-50	-50	
A35-574	A35-574				
Z6 CN 18-09	Z6 CN 18-09	-	-	-200	
Z6 CNT 18-10	Z6 CNT 18-10	-	-	-200	
Z7 CND 17-11-02	Z7 CND 17-11-02	-	-	-200	
JIS					
G4107 SNB7	G4051 S43C	-	-	-30	≤ 40 mm dia.
G4303 SUS 304	G4303 SUS 304	-	-	-200	
SUS 321	SUS 321	-	-	-200	
SUS 347	SUS 347	-	-	-200	
SUS 316	SUS 316	-	-	-200	
SUS 304N1	SUS 304N1	-	-	-200	