



Exploration & Production

GENERAL SPECIFICATION

STRUCTURAL

GS EP STR 201

Materials for offshore steel structures

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1. Scope

1.1 General

1. This specification defines the Company's general requirements for the manufacture and supply of structural materials to be used in the construction of offshore steel structures (such as jackets, decks, module support frames, flare booms, bridges, vent booms, quarters and modules, etc.) or parts of thereof.

For offshore steel structures, this specification shall be read in conjunction with **GS EP STR 101** and **GS EP STR 102**

For floating support hull, this specification shall be read in conjunction with **GS EP STR 653** and **GS EP STR 631**.

For other structures (suction anchors, subsea structures, etc.), this specification shall be read in conjunction with relevant specification or PPS.

This specification shall be read in conjunction with **GS EP STR 301** unless otherwise specified.

2. This specification discriminates "structural materials" from "non-structural materials" as per whether or not they are included into the composition of resisting members of the structure (refer to para. 1.2, 1.3 and 4).

It does not cover the following:

- Finishing materials such as roofing, cladding, partitions, flooring, etc.
 - Cast or forged products (other than lifting pins and axles) see **GS EP STR 202** & **GS EP STR 203**.
3. Where required, this specification shall be used in conjunction with a Project Particular Specification (PPS) detailing the additional tests and requirements or the possible modifications to the present specification, based on the particular design conditions or the local legislation of the structural project.
 4. No deviations from the requirements stated in the present specification shall be permitted unless prior written approval has been obtained from the Company. Refer to para. 6.7 of this specification.
 5. Attention is drawn on certain materials that shall be subject to inspection and approval by a Third Party Inspection (TPI), as referred to in para. 16.3 of this specification.
 6. Attention is drawn too on certain materials that shall be subject to comply with requirements of Classification Society or any particular state regulation. In that case, material shall comply with the most severe requirement. In the event of conflict between this specification and any other contractual document, the Contractor shall inform the Company in writing and receive written clarification or approval from the Company.

1.2 Structural materials

1. This specification covers exclusively carbon steel materials.

It applies to plates, rolled sections, hollow sections, welded tubulars (including welded reducers) and seamless tubulars, having a max. Specified Yield Strength of 500 N/mm². Steels with min. Specified YS above 355 N/mm² shall be subject to special Company's

approval (refer to para. 5.2). It also applies to structural bolting (nuts and bolts) and forged pins or axles.

2. When it is deemed more convenient, this specification can also be used for the fabrication of cold formed tubulars and reducers/cones made by the Roll Bending process or the Press Bending process, although those products are normally covered by the specification **GS EP STR 301**.
3. The materials of following structures shall be defined in separate specifications:
 - Skid structures (skid mounted equipment)
 - Crane pedestal structures
 - Welded Plate Girders (WPG): either as per **GS EP STR 301** or **GS EP STR 304**, with prior agreement with the Company.
4. Cast materials and forged materials (other than pins or axles) shall be covered by specifications to be issued separately.

1.3 Non-structural materials

They are finishing materials and materials of annex structures (such as standard non-alloyed steels, stainless steels, semi-hard or hard steels, galvanized steels, etc.), as well as materials of structural accessories (such as false flooring, grating, stairs, handrails, wire mesh, etc.), which does not jeopardize the overall integrity of the platform.

These materials shall be Low Strength steels (as defined in Table 5.1) unless otherwise noted.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

The order of precedence of the applicable documents shall be:

- The Purchase Order (PO)
- The Project Particular Specification (PPS)
- The present General Specification
- The codes and standards in reference.

Applicable Codes and Standards which are to be used in conjunction with this specification are stated in paragraphs hereafter.

Unless otherwise specifically indicated in writing by the Company, the Supplier shall work in accordance with the requirements specified herein and the applicable requirements of the latest editions at date of Contract award of the referenced Codes and Standards, whenever asked in the present specification.

Where this specification states no overriding requirements, the referenced Codes and Standards shall apply in full.

Standards equivalent to those referred to herein shall not be substituted without written approval of the Company. Approval of equivalent standards will not, in any way, remove responsibility of

the Supplier to meet the requirements of the standards referred to and amended herein, in the event of conflict.

The Supplier shall equip himself with copies of all the reference specifications referred to in this specification and shall make them readily available to all fabrication, testing and inspection personnel involved on the work.

Standards

Reference	Title
ASTM A 6	General requirements for rolled steel plates, shapes, sheet piling, and bars for structural use
ASTM A 307	Carbon Steel Externally Threaded Standard Fasteners
ASTM A 325	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 388	Ultrasonic Examination of Heavy Steel Forgings
ASTM A 490	Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A 578	Straight-beam ultrasonic examination of plain and clad steel plates of special application
ASTM E 23	Notched Bar Impact Testing of Metallic Materials
ASTM E 112	Estimating the Average Grain size of Metals
ASTM E 384	Test Method for Micro hardness of materials
ASTM E 709	Standard Guide for Magnetic Particle Testing
BS 4 Part 1	Structural Steel Sections - Part 1: Specification for Hot-Rolled Sections
BS 4848 Part 2, 4	Hot-rolled structural steel sections: Hollow sections-Equal and unequal angles
EN 462-1	Image quality of radiographs - Part 1: Concept, Image Quality Indicators (wire type), determination of image quality value.
EN 473	Qualification and certification of non-destructive testing personnel
EN 584-1	Industrial radiographic films - Part 1: Classification of film systems for industrial radiography.
EN 1435	Non-destructive examination of welds. Radiographic examination of welded joints
EN 10002-1	Metallic materials - Tensile testing - Part 1: Method of test at ambient temperature
EN 10025	Hot rolled products of structural steels
EN 10029	Hot rolled steel plates, 3 mm thick or above - Tolerances on dimensions, shape and mass.
EN 10045-1	Metallic materials. Charpy impact test. Part 1: Test method



Reference	Title
EN 10113 Part 1, 2, 3	Hot rolled products in weldable fine grain structural steels
EN 10160	Ultrasonic testing of steel flat product of thickness equal to greater than 6 mm (reflection method)
EN 10163 Part 1, 2, 3	Delivery requirements for surface condition of hot rolled steel plates, wide flats and sections
EN 10164	Steel products with improved deformation properties perpendicular to the surface of product
EN 10204	Metallic products - Types of inspection documents
EN 10210 Part 1, 2	Hot finished structural hollow sections of non-alloy and fine grain structural steels
EN 10225	Weldable structural steels for fixed offshore structures - Technical delivery conditions
EN 10306	Ultrasonic testing of H beams with parallel flanges and IPE beams
EURONORM 18	Selection and preparation of samples and test pieces for steel and iron steel products
ISO 148	Metallic materials Charpy pendulum impact test
ISO 898-1	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs with specified property classes - Coarse thread and fine pitch thread
ISO 1027	Radiographic Image and Quality Indicators for non-destructive testing-Principles and identification
ISO 1302	Geometrical Product Specification (GPS) - Indication of surface texture in technical product documentation
ISO 6507	Metallic materials - Vickers hardness test
ISO 9001	Quality management systems - Requirements
ISO 12096	Submerged Arc-Welded Steel Tubes for Pressure Purposes - Radiographic Testing of the Weld Seam for the Detection of Imperfections
SIS 05-59-00	Pictorial surface preparation standards for painting steel surfaces



Professional Documents

Reference	Title
API SPEC 2B	Specification for the Fabrication of Structural Steel Pipe
API SPEC 5L	Specification for Line Pipe
API Q1	Specification for Quality Programs for the Petroleum, Petrochemical and Natural Gas Industry
CSWIP	Requirements for the certification of personnel engaged in NDT

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
ANSI/AWS D1.1	Structural Welding Code - Steel
AWS A5.01	Filler metal procurement guideline

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS EP COR 350	External protection of offshore and coastal structures and equipment by painting
GS EP SPS 009	Corrosion protection of subsea station
GS EP STR 100	Offshore steel structures - General
GS EP STR 101	Design of offshore jacket and subsea structures
GS EP STR 102	Design of offshore topside structure
GS EP STR 202	Cast materials for steel structures
GS EP STR 203	Forged materials for steel structures
GS EP STR 301	Fabrication of offshore steel structures



Reference	Title
GS EP STR 304	Fabrication of welded plate girders (W.P.G.)
GS EP STR 631	CALM buoy terminals
GS EP STR 653	F(P)SO - Hull fabrication requirements

3. Definitions

Throughout this specification, the following definitions shall apply:

- **Supplier** Means the company designated on the Purchase Order form or Contract as being the selected supplier of the said materials.
- **Manufacturer** Means the company or its sub-contractors selected by the Company or the Supplier (as applicable) as the Manufacturer of the said materials.
- **Purchaser** Means the Company or the Supplier (as applicable) which have placed the Purchase Order to the Manufacturer.
- **Inspector** Means the Company's or Supplier's representative(s), (as applicable), or member(s) from an Inspection Agency duly appointed by the Company or the Supplier (as applicable) to act as its representative(s) for the purpose of the contract.
- **PPS** Designates the Project Particular Specification as defined in para. 1.1 above.
- **Approval** Means the authorization in writing given by the Company to the Supplier on a procedure or to proceed with the performance of a specific part of the work without releasing in any way the Supplier from any of his obligations to conform with the technical specifications, requisitions, etc. The words "Approve", "Approved" and "Approval" shall be construed accordingly.

4. Member classification

The following is a reminder of the provisions contained in General Specification **GS EP STR 100** on that matter.

4.1 Structural members

The structural members of the resisting structures are distributed into three categories of importance, mainly in regard of the consequences of their possible failure during platform production or during installation of constituting parts of the platform (lifting of packages, etc.).

(1) Special category members (S)

Failure of any of these members either would cause total or partial destruction of the platform during its production or destruction of parts of the platform during their installation, or they are members that cannot be repaired.

(2) First category members (1)

Failure of any of these members would cause total or partial platform shutdown, but no total or partial destruction of the platform. Repair of these members would only be made if production or installation of the platform is stopped.

(3) Second category members (2)

They are members other than those classified in Special Category or First Category.

This distribution of Structural Members into categories of importance shall be submitted to the Company for prior approval.

When exceptionally, and subject to Company approval, local cans are substituted by a constant thickness member to avoid multiple joints, the member shall be upgraded to Special Category.

As referenced in other specifications, primary structure addresses Special and First category structures as defined above. Secondary structures addresses Second category structures. Tertiary structures addresses non-structural items.

Table 4.1 provides the distribution of Structural Members into categories of importance.

4.2 Non-structural members (NS)

Accessory and finishing elements, i.e. not participating in the overall strength of the platform structures (e.g. cladding, hand-rails, stairs, ladders, grating, false flooring, etc.) constitute a class separate from that of Structural Members defined in the para. 4.1 above.

4.3 Indication of member categories on documents

Materials shall be identified as "S", "1", "2" and "NS" (as shown in para. 4.1 above) on drawings and materials requisitions.

Table 4.1 - Classification of structural members into categories of importance

Category Type of structure	Special category ⁽³⁾ ⁽⁴⁾	First category	Second category
Jacket and piles	- Pad eyes - Piles - Jacket legs ⁽¹⁾ and part of them (ex. cans, bottles, etc.) - Cans of bracings - Buoyancy tanks - Conductor pipes - Crown rings (if any)	- Jacket bracings - Support structure of boat-landings, risers, riser protector (clamps, stub pieces, etc.) - Conductor guides (funnels and supporting plates)	- Boat landings - Bumpers - Riser protector - Mudmats - Shock cells
Deck	- Pad eyes and nodes to which they are connected - Deck legs and cans - Main girders with depths ≥ 800 mm - Critical nodes (based on design) - Transition pieces between deck and piles - Skidding beams - Bearing nodes (bridges, flares, turbines, etc.)	- Other members of the main structure - Rolled sections and WPG with $400 \leq$ depths < 800 mm - Bracings of trusses - Gussets (thk ≥ 15 mm) welded on First Category members - Crane boom rests	- Secondary girders with depths < 400 mm - Joisting - Stiffening elements of the secondary structure - Hatch covers - Plating

Category Type of structure	Special category ⁽³⁾ ⁽⁴⁾	First category	Second category
Modules	- Pad eyes and nodes to which they are connected - Structural members that are critical during lifting	- Main girders, columns and bracings of trusses - Gantry structures	- Secondary members of the support structure
Helideck	- Pad eyes	- Deck legs (for helideck landing pad not integrated to the superstructures) - Main girders columns and bracings	- Secondary members of the support structure
Lifting appliances and accessories	- All components subjected to concentrated stresses during lifting, such as pad eyes, etc. - Spreader beams - Crane pedestals up to and including the slewing ring	- Elements submitted to heavy stresses (dynamic loads among other stresses)	- Other structural members - Guides and bumpers of lifting aids
Other structures ⁽²⁾ ⁽⁵⁾	- Pad eyes and nodes to which they are connected - Bearing nodes, cans of vent booms and bridges	- Primary members of the main structure - Main lattice girders of vent booms and bridges - Skidways, transition beams, sub-structures - Barge grillage - Main components (bracings) of sea fastening - Doubler plates on Special and First Category members	- Secondary members of the support structure - Rigging platforms

- (1) Jackets legs (except cans) with inner leg piles may be of First Category only when so approved by Company.
- (2) Any other structures which are not mentioned in this table, including inter-platform catwalks, superstructures of living quarters, vent booms, technical rooms or similar, etc.
- (3) All pins, axles, castings and forgings shall be classified as Special Category (as for all pad-eyes).
- (4) When multiple cans on the same member are replaced by a single element, this element is classified as Special Category. Conical transitions to cans are also classified as Special Category.
- (5) For other structures such as FPU, FPSO, Subsea structures, Suction Anchors..., see relevant GS or PPS for Category definition.

5. General characteristics of structural steels

5.1 Steel groups

In this specification, steels are conventionally divided into 4 steel groups, according to their Minimum Specified Yield Strength, as shown in Table 5.1. These 4 steel groups are different from the AWS ones and shall not be considered for the Welding Qualification.

Table 5.1 - Conventional Definition of steel Groups

Steel group	Conventional steel designation	Min. Specified Yield Strength (MSYS)
I	Low Strength steels (LS steels)	$YS \leq 262 \text{ N/mm}^2$ (38,000 psi)
II	Medium Strength steels (MS steels)	$262 < YS \leq 295 \text{ N/mm}^2$ (42,800 psi)
III	High Strength steels (HS steels)	$295 < YS \leq 355 \text{ N/mm}^2$ (51,500 psi)
IV	Extra High Strength steels (EHS steels)	$355 < YS \leq 500 \text{ N/mm}^2$ (72,540 psi)

Note: $1 \text{ N/mm}^2 = 1 \text{ MPa} = 145.079 \text{ psi}$

5.2 Selection and designation of steel grades

The conventional designation of steel grades is based on the Specified Mini. Yield Strength in N/mm^2 for the smallest thickness range.

The usable grades as regard to steel product types are given in Table 5.2.

The steel grades indicated between brackets in Table 5.2 should be avoided. The use of EHS steel grades shall have prior approval of Company for each Project Development phase and application. S 460 steel grade and above are forbidden for driven piles, driven conductor pipes and jacket nodes (cans and incoming stubs). EHS steels shall not be used for 2nd Category materials.

The tensile properties to be satisfied for each steel grade are defined in the sections pertaining to each steel product in this specification.

As a general rule, steel grades within a same construction should be chosen so that they are very different from one another. In addition, the number of selected steel grades should be as reduced as possible (2 or 3 maximum).

Table 5.2 - Usable steel grades according to products types

Steel group	Steel grade designation	Plates	Rolled sections and hollow sections	Welded tubulars	Seamless tubulars
I Low Strength steels (LS)	S 235	X	X	X	X
	(S 255)	X			
II Medium Strength steels (MS)	S 275	X	X	X	X
	(S 295)	X			
III High Strength steels (HS)	(S 315)			X	X
	S 355	X	X	X	X
IV Extra High Strength steels (EHS)	S 420 (1)	X	X (2)	X	
	S 460 (1)	X	X (2)	X	
	(S 500) (1)	X	X (2)	X	
Notes: - The symbol "S" is allocated to "Structural Steels". - Steel grades between brackets should be avoided.					
(1) These steel grades shall have prior approval of the Company.					
(2) EHS steel grades shall not be permitted for hollow sections.					

5.3 Selection and designation of steel qualities

5.3.1 General

Steel qualities are defined by:

- Notch impact toughness
- Carbon Equivalent (CE) and Pcm

and, in special cases, by:

- The reduction of area at tensile test in the through thickness direction
- The physical properties after stress relieving heat treatment (PWHT)
- The notch impact toughness after accelerated strained ageing (in case of steel to be cold or warm formed without subsequent heat treatment in the fabrication/construction which is to take place later on).

Selection of steel quality shall be subject to the Company's prior approval.

5.3.2 Notch impact toughness

a) All products shall have an impact toughness guaranteed by the producing mill. The impact test shall be actually carried out only if the thickness is equal to or more than the following ones:

- 8 mm for KT 0 to KT - 50 qualities inclusives
- 13 mm for KL + 20 quality
- 10 mm for all other qualities.

For steels qualities K - 20, K - 40 and K - 50 in thickness lower than 8 mm where the impact test cannot be carried out or is not required, then the steel shall show an equivalent index of ferritic grain size ≥ 8 when determined in accordance with [ASTM E 112 Std.](#)

The impact test shall be of the CHARPY V-notch type complying with Standard [EN 10045-1](#) or [ASTM E 23](#). Depending on thickness, it consists of one or two sets of three impact test specimens as follows:

- One set below the surface for $t \leq 50$ mm
- One set below the surface and one set at mid-thickness for $t > 50$ mm.

b) Impact toughness is symbolized by the letter K followed by:

- The letter T or the letter L as per whether the longitudinal axis of specimen is transverse or parallel to the main rolling direction of steel
- The impact test temperature stated in Celsius degrees.

Example: KT - 20 means that impact test specimens shall be cut in the transverse direction as regard to main rolling direction and tested at -20°C .

c) For each usable steel grade, the impact test procedure and the required absorbed energies shall be as stated in Table 5.3 for full size specimens, according to structure Member Category in the construction and geographical zone where the structure will be located.

As far as possible, full size specimens shall be used. If for practical reasons sub-size specimens are deemed necessary, then they shall be of the largest possible size considering, on the one hand the product thickness and configuration, and on the other hand, the specimen dimensions stated in Table 5.4. For sub-size specimens, the absorbed energy requirements shall be those for full size specimens (see Table 5.3) multiplied by the corresponding factors given in the Table 5.4 hereafter.

d) For Special Category products (i.e. with KT impact test) the requirements for KL impact test shown in Table 5.3 must be guaranteed by the steel-producing mill.

The Company reserves the right to carry out tests, at any time, for checking the longitudinal impact toughness of these steels.

**Table 5.3 - Required absorbed energies at CHARPY V-notch test
(full size 10 x 10 mm specimens)**

Steel grade	CHARPY-V Energy (Joules) (Mini. Average/Mini. Single)	
	Transverse (KT)	Longitudinal (KL)
	Special category	1 st and 2 nd categories
S 235 and (S 255)	Average: 28 Single: 21	Average: 28 Single: 21
S 275 (S 295) and (S 315)	Average: 32 Single: 24	Average: 32 Single: 24
S 355	Average: 40 Single: 30	Average: 40 Single: 30
S 420 (1) S 460 (1) (S 500) (1)	Average: 50 Single: 37	Average: 50 Single: 37
Transverse (KT): Specimens cut transverse to main rolling direction. Longitudinal (KL): Specimens cut parallel to main rolling direction.		
(1) These steel grades shall have prior approval of the Company.		

Table 5.4 - CHARPY V-notch test. Sub-size specimens

Specimen size (mm)	Multiplying factor
10 x 10	1
10 x 7.5	5/6
10 x 6.7	7/9
10 x 5	2/3

- e) Where one specimen fails to conform to the specified requirements, a retest may be accepted by the Inspector pending further investigation of the failure is made by the Supplier. Where it is thought that the failure can be an isolated case, then the Inspector may accept the testing of three additional specimens. The average value of the six specimens shall be at least equal to the minimum average value required, and each of the three additional samples shall satisfy the minimum individual requirement.
- f) The selection of steel quality regarding impact toughness shall be determined based on the following:
- The geographical location of structures and construction site (as per Table 5.5) (the most severe shall govern)
 - The Member Category (as per para. 4.1)
 - The thickness of the structural component. Thickness is defined hereafter.
 - Table 5.6 gives the steel qualities required under these conditions.

- For Special Category products, when it is practically impossible to perform the notch impact test with a transverse specimen, even with a sub-size specimen, the test shall then be performed using a longitudinal specimen, the test temperature being unchanged (Note that Table 5.3 gives identical requirements for absorbed energy, whatever the specimens are longitudinal or transverse). The Company shall be informed prior to this change.

- In the present paragraph, "thickness" means a Reference Thickness defined as follows:

In a butt connection, the Reference Thickness is the thickness of the steel plate. For butt welds at blended transitions between plates or tubulars of different thicknesses, the Reference Thickness is that of the thinner part. For welds not of straight butt configuration (e.g. stub to can welds or ring stiffener to can welds) the thickness of the abutting members (e.g. stub thickness or ring stiffener thickness) shall be the Reference Thickness. In the particular case of crown shims, the Reference Thickness shall be that of the related platform piles. In case of rolled sections, the thickness to take into account is that of flanges.

g) Note: Within the scope of this specification, defining a steel quality regarding impact toughness (examples: KT - 20, KL 0 quality, etc.), automatically implies particular requirements about chemical composition for the said material. These requirements on chemical composition shall be as defined in the sections pertaining to each product in this specification.

Table 5.5 - Definition of geographical zones

Geographical zone	Design temperatures ⁽¹⁾	Examples of sites
0 (Very Cold seas) ⁽²⁾	$T_c < -15^{\circ}\text{C}$	Barents Sea - Caspian Sea
1 (Cold seas)	$-15^{\circ}\text{C} \leq T_c \leq 0^{\circ}\text{C}$	- North Sea - Baltic Sea - Irish Sea - Tierra del Fuego
2 (Temperate seas)	$0^{\circ}\text{C} < T_c \leq +15^{\circ}\text{C}$	- English Channel - Bay of Biscay - Western Mediterranean
3 (Warm seas)	$T_c > +15^{\circ}\text{C}$	- Gulf of Guinea - Arabian/Persian Gulf - Indonesian Sea - Red Sea - Eastern Mediterranean
(1) Average temperature of coldest month minus 5°C at final location of the structure. For structure critical during construction or transportation, then the design T_c shall be based on those conditions (lifting/pulling points, sea-fastening, crane test, etc). (2) Very Cold Seas cases are not treated in this specification. A Particular Project Specification shall be issued for steel definition, subject to Company approval.		

Table 5.6 - Definition of steel qualities as regard to impact toughness

Geographical zone	Thickness t (mm)	Member category		
		Special	First	Second
1 (Cold seas)	$t \leq 20$	KT - 20	KL 0 ⁽²⁾	KL + 20
	$20 < t \leq 40$	KT - 40	KL - 20	KL 0
	$40 < t \leq 55$		KL - 40	KL - 20
	$55 < t \leq 80$	KT - 50	KL - 50	KL - 30
	$80 < t \leq 105$			
2 (Temperate seas)	$t \leq 12.7$	KT 0 ^{(1) (2)}	KL + 20 ⁽²⁾	KL + 20
	$12.7 < t \leq 19.5$		KL 0 ⁽²⁾	
	$19.5 < t \leq 25.4$	KT - 20	KL - 20	KL 0
	$25.4 < t \leq 38.1$			
	$38.1 < t \leq 65$	KT - 40		
	$65 < t \leq 105$	KT - 50	KL - 40	KL - 20
3 (Warm seas)	$t \leq 20$	KT 0 ^{(1) (2)}	KL + 20 ⁽²⁾	KL + 20
	$20 < t \leq 25.4$		KL 0 ⁽²⁾	
	$25.4 < t \leq 40$	KT - 20	KL - 20	KL 0
	$40 < t \leq 45$			
	$45 < t \leq 83$	KT - 40		
	$83 < t \leq 110$	KT - 50	KL - 30	KL - 20
	$110 < t \leq 150$		KL - 40	

KT: Test specimens cut perpendicularly to main rolling direction
KL: Test specimens cut parallel to main rolling direction
(1) Impact toughness KL instead of KT, only for rolled sections with flange thickness ≤ 20 mm, test temperature remaining unchanged.
(2) Minimum testing temperature shall be -20°C for QT steel plates and rolled sections, unless otherwise agreed.

5.3.3 Carbon Equivalent (CE) and Pcm

The Carbon Equivalent calculated on ladle using the International Institute of Welding (IIS) formula shall meet the requirements stipulated in Table 5.7 depending on material thickness.

For TMCP steel and all steels with $C \leq 0.12\%$, the requirements of Pcm contained in Table 5.7 shall apply in addition to requirements of CE.

The CE and Pcm computed on product shall not exceed the CE and Pcm computed on ladle by more than 0.02% and 0.01% respectively.

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15} \%$$

$$P_{cm} = C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B$$

Note that ladle CE and Pcm of Quenched and Tempered (QT) steels and Extra High Strength (EHS) steels shall not exceed 0.41% and 0.22% respectively (refer to Table 5.7).

Table 5.7 - Carbon Equivalent and Pcm on ladle for structural steels

Thickness of product	Pcm All products with C ≤ 0.12% ⁽²⁾	CE _{IIIS} max. ladle All steels whatever C contents ⁽²⁾		
		Seamless tubulars	Rolled sections, hollow sections ⁽¹⁾	Plates, welded tubulars
t ≤ 20 mm	0.22	0.42	0.41	0.40
20 < t ≤ 30 mm	0.23	0.43	0.42	0.41
30 < t ≤ 51 mm	0.23	0.44	0.43	0.42
51 < t ≤ 70 mm	0.23	NA [*]	NA [*]	0.43
t > 70 mm	0.24	NA [*]	NA [*]	0.44

*NA: Not Acceptable

(1) The Reference Thickness shall be the flange thickness.

(2) For QT steels and EHS steels, max. CE and Pcm shall be 0.41% and 0.22% respectively.

5.3.4 Steels with specified reduction of area in the through thickness direction (Z 35 quality)

For plates or rolled sections with thickness > 25 mm (or less if deemed necessary by structural design) which are heavily stressed in the through thickness direction due to large welding shrinkage or heavy service stresses, cross assemblies with complete/full or partial joint penetration and for cans, with possibility of inducing lamellar tearing, shall be of Z 35 quality of standard [EN 10164](#).

Z 35 steel shall also be required in complete/full or partial joint penetration groove welded angular connections or heavy fillet weld for the through member when the two following conditions are simultaneously met:

- $1.5e + s \geq 55$
- $e \geq 20 \text{ mm}$

(s = main member thickness, e = branch member or effective throat weld thickness, expressed in mm)

Types and number of tensile specimens to be cut as well as their sampling location in the product shall comply with standard [EN 10164](#). However, for plates three tensile tests shall be cut and tested at each end of mother plate (see definition of mother plate in para. 7.1.3 of this specification) whatever the sulphur content. When traceability (regarding rolled plate) of individual plates is not ensured, then three tensile specimens shall be cut at each end of

individual plate. For rolled sections, the location of sampling and test units shall be as indicated in para. 8.5.4 and 8.8 of this specification.

Acceptance criteria: the required minimum average reduction of area shall be 35%, without any single value lower than 25%. In addition, the Tensile Strength measured at each test shall not be lower than 80% of minimum specified tensile strength.

For special and first category plates or rolled sections with thickness ≥ 16 mm, the sulphur and the phosphorus contents in the ladle analysis shall not exceed 0.005% and 0.020% respectively.

Delivery condition for Z 35 steels shall be Normalized or TMCP.

5.3.5 Steels with specified physical properties after stress relieving heat treatment (PWHT)

Where the thickness, complexity or high level of stresses of the welded assemblies will require or, at least, indicate the probable requirement of stress relieving heat treatment after welding, the corresponding steels shall be ordered with tests on their physical properties (at least for tensile and impact properties, exception is made of reduction of area in the through thickness direction) after such a heat treatment.

As a rule, this heat treatment shall be defined by the steel producing mill and transmitted to the Company and Purchaser for information. The holding temperature should not be lower than $580^{\circ}\text{C} \pm 15^{\circ}\text{C}$ for controlled rolled steels, 30°C below the tempering temperature for QT steels and $600^{\circ}\text{C} \pm 15^{\circ}\text{C}$ for other steel processing methods, for a holding time of 2 minutes per mm of thickness.

Acceptance tests shall then be performed on samples having undergone the heat treatment under simulated conditions. The results obtained shall comply with requirements stated in this specification concerning steel qualities and grades.

Steels of this quality shall be symbolized by the letter "P" (for "Post Weld Heat treatment").

The "P" quality steel is required for materials of Reference Thickness exceeding 60 mm for Special Category and 80 mm for First Category members joined by full penetration welds, unless a smaller thickness is specified in the PPS or in Company approved material requisition. In a full penetration weld (e.g. butt weld, T, K, Y welds, etc.), the Reference Thickness (see para. 5.3.1.f) is that thickness which governs the thickness of the weld. For example: thickness of thinner member in a butt weld; thickness of stub in stub/can junction in a tubular node. In the particular case of weld between crown shims and jacket piles, the Reference Thickness is that of the jacket piles (the P quality is not required for crown shim materials).

Under Contractor responsibility and subject to Company approval the requirement for heat treatment may be avoided/modified pending on the actual fabrication sequence (can without girth weld, reference thickness less than above figure, no PWHT, CTOD).

5.3.6 Steel for forming

Steel materials that are to be subject to a cold or warm forming process (including forming of welded tubular) without the intent of performing a subsequent heat treatment, shall be ordered with impact toughness test made after a strain ageing test when the percentage strain (PS) which is anticipated at fabrication stage is more than the values indicated in Table 5.8. If the PS is more than 6%, hot forming and/or heat treatment are mandatory.

Table 5.8 - Limits of Percentage Strain for cold forming without strain ageing test (see 5.3.6.1)

Geographical zone	Max. acceptable Percentage Strain (PS)
Temperate seas and warm seas	5%
Cold seas	4%

Note: To clarify the following requirements, it is reminded that the plate capability of plastic elongation (uniform elongation) is limited to 10% approx.

Forming process which results in a percentage strain exceeding 6% shall meet the following conditions:

- Either forming shall be carried out at a temperature $\geq 550^{\circ}\text{C}$
- Or forming shall be carried out at a temperature $\geq 880^{\circ}\text{C}$
- Or forming is to be carried out in cold condition then, it shall be subject to subsequent normalization or quench tempering or stress relieving. A Magnetic Particle Inspection (MPI) shall be performed before and after heat treatment. When stress relieve heat treatment is applied, either as post forming heat treatment or as post welding heat treatment, in addition to the other specified tests, micrographic examination shall be carried out as described here below (*).

5.3.6.1 5Steel with specified impact toughness after strain ageing

- A verification of impact toughness after accelerated ageing shall also be made in the case of welded tubulars made from cold formed plates (press bending, roll bending, etc.) where the PS is over the limits stipulated in Table 5.8. Refer to para. 10.6.1.b of this specification. Heat treatment shall be mandatory for any cold forming resulting in a permanent straining exceeding 10% for steels with $\text{SMYS} \leq 355 \text{ MPa}$ or 8% for steels with $\text{SMYS} > 355 \text{ MPa}$.
- The Percentage Strain (PS) due to forming is defined as follows by the max. permanent straining percentage obtained over the stretched plate surface.

$$\text{PS \%} = \frac{t}{D} \times 100$$

- $$\left\{ \begin{array}{l} t = \text{material thickness} \\ D = \text{forming diameter at mid - thickness of material} \end{array} \right.$$

- The strain ageing test shall be carried out under the following conditions on a steel sample:
 - Tensioning of the sample so as to obtain the same permanent elongation as that anticipated for the final product
 - Then artificial ageing by heat treatment at 250°C during one hour.

Charpy V-notch impact test shall be carried out on the steel sample in the strained condition and in the strained plus ageing condition.

Impact test specimens shall be cut from the sample according to the same direction, as regard to the main rolling direction, as that prescribed for the steel quality in question.

Location of impact test specimens through the material thickness shall be as per para. 5.3.2 of this specification.

The test results shall meet the related requirements stated in this specification for steel grades and qualities (refer to Table 5.3).

d) Steels of this quality shall be symbolized by the letter "A" (for "Ageing").

5.3.6.2 Materials for cold or warm forming with or without subsequent heat treatment

The Purchaser shall obtain from the steel producing mill all the necessary instructions and recommendations to perform the said forming and heat treatment, so as to obtain the required steel characteristics at fabrication stage.

The information relating to heat treatment shall be made known to the Company.

Tensile tests and impact tests as per this specification shall be required on material further to simulated forming and subsequent heat treatment, if any.

(*) In the case of cold forming with subsequent stress relieve heat treatment; the micro structure from the base metal of test sample before forming and after forming/stress relieve shall be examined for comparison, to ensure that steel structure does not vary. After etching, the through thickness section from the extrados to the intrados shall be examined with a suitable magnification. At any location in the through thickness, an increase of grain size, i.e. a decrease of grain size N°, by more than one point to [ASTM E 112](#), between the structure before forming and after forming/stress relieve, shall not be acceptable. Steel/plate producing mill shall guarantee the plate against the grain size increasing sensitivity. Testing by producing mill is not required. The test shall apply at the forming production stage.

5.3.6.3 5Materials for hot forming

All materials to be used in hot forming shall be of the normalized type, according to [EN 10113-2 Std.](#)

The Purchaser shall obtain from the steel producing mill all the necessary instructions and recommendations to perform the said hot forming and, when necessary, the heat treatment to be made after forming, so as to obtain the required steel characteristics at fabrication stage.

Those informations shall be communicated to the Company.

Tensile tests and impact tests as per this specification shall be required on material further to simulated hot forming, and subsequent heat treatment, if any.

5.4 Complete designation of a steel

Within this specification, the complete designation of a steel (i.e. its symbolic designation) shall consist of:

- The letter "S" (for "Structural") followed in all cases and in order by
- The designation of its grade (see para. 5.2)
- The designation related to impact toughness (see para. 5.3.2).



Then, when applicable, the above designation is completed in order by:

- The letter "P" for steels with specified physical properties after stress relieving heat treatment (see para. 5.3.5)
- The letter "A" for steels with specified impact toughness after Strain Ageing test (see para. 5.3.6). However, the product shall be marked with this letter only when so explicitly required in the Project Particular Specification
- The designation "Z 35" for steels with specified reduction of area in the through thickness direction (see para. 5.3.4).

Examples:

- S 355. KT - 20.Z 35
- S 355. KT - 20.P. Z 35
- S 355. KT - 20.A. Z 35.

Note: Carbon Equivalent (or Pcm) is not indicated in the symbolic steel designation. This characteristic is implicitly related to material thickness (see para. 5.3.3).

6. General requirements for structural steels

6.1 Steel designation

Steels shall be designated as stated in para. 5.4 of this specification.

Steels shall be referenced as such on all engineering documents (drawings, specifications, requisitions, etc.) with reference to this specification.

6.2 Sourcing of materials

6.2.1 All materials shall be new. The list of Manufacturers shall be submitted to the Company for approval prior to order.

6.2.2 When it is agreed with the Company that materials can be supplied from stocks, then the following shall be met:

- The list of potential stockists/stock holders shall have prior approval of the Company
- The original Mill certificates of materials shall be made available to the Inspector for review. The certificates made by dealers or stockists shall not be acceptable. Certified true copy of a Mill certificate made by an international and Company recognized certification authority may be accepted provided that the original Mill certificate can be shown to the Inspector for review
- The original markings shall be easily visible on products.

In addition, the Company or Purchaser reserves the right to require additional or confirmatory tests (chemical analysis, mechanical tests, thickness measurements, etc.) from the stockist and to undertake a visit at stockist's storage area to check the said products as regard to corrosion, surface condition, storage condition, markings, etc.

6.3 Traceability of materials

The Manufacturer (or stock holder) shall ensure full traceability of the supplied materials. The in-house traceability procedure shall be made available to the Inspector on request.

6.4 Substitution of Materials

6.4.1 The use of steel grades, qualities and dimensions other than those required by this specification shall not be made unless a written approval from the Company is obtained.

6.4.2 Substitution of a steel for another (from this specification or a different standard) shall not in any manner modify the requirements of this specification regarding acceptance tests and inspections to be made (with related criteria), marking to be applied on products and documentation to be supplied.

Appendix 1 to this specification shows, for information, some equivalent steels in ASTM and API Stds provided that, in some cases, certain of the steel characteristics are to be further checked or measured for full compliance to this specification.

Any substituted steel from another Company approved Std (e.g. BS, DIN, NF, ASTM, API, etc.) shall, in addition, fully comply with the requirements of the said Std.

6.4.3 Steel quality KL + 20 may be replaced by a steel of an equivalent quality defined in any Company approved Std provided that this steel is totally in accordance with the said Std and also that tensile and CE/Pcm properties, as a minimum, remain in accordance with this specification.

6.4.4 For convenience, grouping of steel qualities may be proposed by the Manufacturer/Supplier, e.g. by up-grading steels in a higher quality (e.g. KL - 20 quality in lieu of KL 0 quality, KTO in lieu of KLO, etc.).

6.5 Manufacturing Procedure Specification (MPS)

The Manufacturer shall establish a detailed specification (called MPS herein) for the manufacture and inspection of proposed materials, giving full details of the characteristics of the materials, describing all proposed manufacturing and inspection operations in their correct sequence together with their parameters of execution. The proposed specification shall include, but not be limited to, all information concerning the following:

- Steel making process
- Deoxidization method
- Special treatment(s)
- Aimed chemical analysis, minimum and maximum working limits (ladle and product) selected by the Manufacturer for the order
- Manufacturing process/delivery condition of steel products (e.g. normalizing, etc.)
- Proposed Welding Procedure Specifications (WPS) for welded products
- Visual inspection procedure
- Dimensional procedures

- Non-Destructive Testing (NDT) procedures
- Qualification of welders (for welded products) and NDT Inspectors.

This detailed MPS shall be submitted to the Company four (4) weeks mini. before commencement of production.

6.6 Quality assurance/quality control

6.6.1 The Manufacturer (or stock holder) shall operate a Quality Assurance system approved by a recognized authority. The quality Assurance Manual shall be submitted to the Company.

6.6.2 Four (4) weeks prior to the commencement of the materials manufacture, the Manufacturer shall prepare and submit to the Company a written Quality Control Plan which describes the inspections to be performed at all stages of manufacture of materials. The Quality Control Plan shall set forth "witness", "hold", "review" and "monitor" stages.

6.7 Technical queries/non-conformance reports

6.7.1 All Supplier's requests for clarifications or deviations to the Company specifications shall be submitted to the Company only through Technical Queries (TQ), the format of which shall have prior approval of the Company.

A deviation to specifications shall not be considered as accepted as long as it has not been submitted to and accepted by the Company through a Technical Query.

6.7.2 Approval given by the Company to any Supplier's work procedures, specifications, requisitions, etc. shall not release in any way the Supplier from its obligation to meet the Company specifications.

6.7.3 Any work performance or any test result which is found, at a later date, not in conformance with the Company specifications or agreed procedure shall be subject to a Non-Conformance Report (NCR) to be issued by the Supplier for submission to the Company. NCR report shall indicate corrective action intended by the Supplier.

7. Steel plates

7.1 General

7.1.1 This section specifies requirements for steel plates. The use of wide flats shall not be permitted.

7.1.2 Steel plates shall fully comply (including testing and inspection methods and procedures) with the following relevant standards for the steel grades and qualities which meet the requirements of this specification, including the requirements stated in section 5, unless otherwise stated in the following:

- [EN 10025 Std](#) or [EN 10113 Std](#): Parts 1, 2 and 3 for S 235 steel grade and any steel (except S 420, S 460 and S 500) with impact testing temperature of -20°C and above
- [EN 10225 Std](#) for S 420, S 460 and S 500 steel grades and any steel with impact testing temperature below -20°C.

7.1.3 The term "mother plate" (or, otherwise, "rolled plate" or "parent plate") designates the whole of the plate which has the same thickness and heat treatment (if any) as that of the finished product, obtained from one slab.

7.2 Usable steel grades

As per Table 5.2, the usable grades shall be:

- S 235, S 275 and S 355

However, as mentioned in para. 5.2, the supplementary grades S 255 and S 295 may also be used, but only if so previously agreed with the Company.

- S 420 and S 460 (subject to prior approval of the Company for each Project development phase and application).

7.3 Steel making process

7.3.1 Steel making process shall be the Basic Oxygen Converter or the Basic Electric Furnace. In all cases rimming steel (i.e. equivalent to deoxidization method "FU" of [EN 10025 Std](#)) shall not be permitted.

7.3.2 Steel shall be as follows:

- For steel qualities K + 20 and K 0, steel shall be semi-killed as a minimum
- For steel qualities K - 20, K - 40 and K - 50, steel shall be fully killed (i.e. equivalent to deoxidization method "FF" of [EN 10025 Std](#)) and shall have a fine grain structure containing nitrogen binding elements in amount sufficient to bind the free nitrogen
- All Z 35 steels shall be fully killed and silico-calcium treated.

7.3.3 Steel making process, deoxidization method, as well as special treatments, when applicable, (such as desulphurization treatment, silico-calcium treatment, degassing, etc.) along with casting method (ingot or continuous casting) shall be stated to the Company when the bids are submitted.

7.4 Plate manufacturing/Delivery condition

The delivery condition of steel plates shall meet the following requirements:

7.4.1 For EHS steel grades (i.e. grades above S 355), the delivery condition shall be TMCP (with or without accelerated cooling) or QT. Direct quenching after rolling followed by tempering is considered as equivalent to conventional quenching and tempering (QT)

7.4.2 Steel plates of Special and First Category with thickness less 65 mm than shall be in TMCP-AcC Delivery Condition (Thermo mechanically rolled + Accelerated Cooling)

7.4.3 As regard to as-delivery conditions, the following thickness limitations shall apply:

- $t \leq 100$ mm for thermo mechanical rolled plates and for QT plates
- $t \leq 150$ mm for normalized and normalized rolling plates
- $t \leq 40$ mm for as-rolled plates, always providing that steel quality is KL 0 or KL + 20, or $t \leq 25$ mm for as-rolled sections. Otherwise, as-rolled plates are not permitted.

7.4.4 Minimum reduction ratio of concast slab to plate thickness shall be 3.5 to 1 (3 to 1 for tubulars used in piles).

7.5 Mechanical properties

7.5.1 The tensile properties of finished plates shall meet the requirements of Table 7.1.