TECHNICAL SPECIFICATION

WELDABLE STRUCTURAL STEELS FOR FIXED OFFSHORE STRUCTURES (Amendments/Supplements to BS 7191)

DEP 37.19.10.30-Gen.

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DESIGN AND ENGINEERING PRACTICE

USED BY

COMPANIES OF THE ROYAL DUTCH/SHELL GROUP

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

PART I INTRODUCTION

1.1 SCOPE

This DEP gives the minimum requirements for the supply of weldable structural steel for use in fixed offshore structures. Part III of this DEP gives amendments and supplements to BS 7191:1989 (including amendments AMD 6750 and AMD 6885) and shall be used in conjunction with that standard. This specification covers steel plates, hot rolled sections and seamless tubulars. Steel plates covered by this specification are suitable for manufacture of welded sections and tubulars although their fabrication is subject to the conditions specified in the relevant fabrication specification. This DEP is intended to apply to steel for primary applications.

In addition to the normal BS 7191 steel grades there are a number of steel grades introduced in this DEP which are intended for use by Group companies operating in locations outside the North Sea. These steel grades are referred to throughout this DEP as supplementary grades. The basis for the supplementary grades is given in Appendix 2. The selection of supplementary grades will depend upon the specific requirements of the operating companies. Unless otherwise specified in this DEP, the general supply requirements for the supplementary grades shall be in accordance with BS 7191:1989.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIPM, 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 and Manufacturers/Suppliers nominated by them, (i.e. the distribution code is "F" as described in DEP 00.00.05.05-Gen.).

This DEP is intended for use in Exploration and Production companies that require the use of weldable structural steel for fixed offshore structures.

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 DEFINITIONS

1.3.1 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.

1.3.2 Specific Definitions

The specific definitions in this DEP are as defined in BS 7191 clause 2, with the addition of the following:

Supplementary grades are steel grades not included in BS 7191 but which are included in this DEP in order to meet the requirements of users operating outside the North Sea.

1.4 ABBREVIATIONS

AR - As rolled

COD - Crack Opening Displacement

NOTE: The term COD is used in BS 7191 but has now been superseded by the term CTOD. Throughout the text of this DEP, the term CTOD is used.

CTOD - Crack Tip Opening Displacement

FCAW - Flux cored arc welding

FL - Fusion line

GCHAZ - Grain Coarsened Heat Affected Zone

HAZ - Heat Affected Zone

ICHAZ - Intercritical Heat Affected Zone

N - Normalised

PWHT - Post Weld Heat Treatment

QT - Quenched and Tempered

SCHAZ - Subcritical Heat Affected Zone

SAW - Submerged arc welding

TMCR - Thermomechanical Controlled Rolling (this is equivalent to TMCP, Thermomechanical Controlled Process)

1.5 CROSS-REFERENCES

Where cross references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced by this DEP are listed in (Part IV).

PART II INSTRUCTIONS FOR USE

In this DEP, amendments to BS 7191:1989 fall into the following categories:

-	"Substitute"	Where the text has been substituted for the complete BS 7191 clause or paragraph;
-	"Modification"	Where the BS 7191 clause or paragraph has been modified. Only the modified portions will be detailed in this standard.
-	"Addition"	Where additions have been made to the BS 7191 clause or paragraph;
-	"Additional clause"	Where new numbered clauses or paragraphs are added. They are numbered in sequence to existing BS 7191 clause or paragraph numbers;
-	"Delete"	Where the complete BS 7191 clause or paragraph is to be disregarded.

Unless amended by this DEP, the existing text in BS 7191 shall apply.

In Part III of this DEP, the numbers in the left hand margin are those of the BS 7191 clauses or paragraphs to which they refer.

PART III AMENDMENTS/SUPPLEMENTS TO BS 7191:1989

FOREWORD

Substitute fourth paragraph:

The supplier shall implement a quality system in accordance with ISO 9001 or an approved equivalent.

SECTION ONE. GENERAL

CLAUSE 1 SCOPE

Modification to first paragraph:

This British Standard specifies requirements for weldable structural steels to be used in the fabrication of fixed offshore structures in the form of plates, up to and including 150 mm thick, sections up to and including 40 mm thick and complying with BS 4848: Parts 2, 4, and 5 and BS 4: Part 1, and seamless tubulars up to and including 40 mm thick.

CLAUSE 3 GENERAL

3.1 GRADE DESIGNATIONS

Addition:

Suffix B Charpy V-notch test at room temperature (as BS 4360)

Suffix C Charpy V-notch test at 0 °C (as BS 4360)

NOTE: These designations are applied to supplementary grades only.

NOTE: Non-optional modifications to BS 4360 for M-grades include:

a) Modified chemistry

b) Reduced Tensile Strength

c) Transverse Orientation for Charpy impact tests.

3.2 STEEL PRODUCTS

Substitute clause

The steel products shall comply with the general requirements of this standard and with the specific requirements of the grade concerned plus options B1, B4, B5, B7, B8 and B9 in Appendix B, which shall also be mandatory. Where any of the other options given in Appendix B are called up at the time of enquiry and order, the steel products shall, in addition, comply with the requirements of these options.

CLAUSE 4 INFORMATION TO BE SUPPLIED BY PURCHASER

4.1 GENERAL

Delete clause (c)

Substitute

(c) Minimum specified CTOD value for HAZ toughness tests (when option B.9 and section F are applied).

CLAUSE 5 STEELMAKING AND MANUFACTURING PROCESS

5.3 LIMITS AND SEGREGATION CONTROL FOR CONCAST MODIFIED GRADES

5.3.1 Substitute clause:

The continuous casting process shall be limited to production of material having thickness up to and including 70 mm.

5.4 PLATE FORMING PROCEDURES FOR MODIFIED GRADES

Substitute:

Information as required by options B.4 and B.5 shall be provided by the Manufacturer. Provided recent test data acceptable to the Principal is available, no specific testing will be necessary.

CLAUSE 6 SUPPLY CONDITION

6.1 Substitute:

Plates of grades 275 and 355 shall be supplied in either the normalised condition or the TMCR condition.

6.2 Substitute:

Plate of grade 450 shall be roller quenched and tempered. Option B.7 shall apply.

6.3 Substitute:

Sections of grades 275 and 355 over 25 mm thick shall be normalised unless specified otherwise by the Principal.

CLAUSE 7 CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES

7.1 LADLE ANALYSIS

7.1.1 General

Addition:

The chemical composition of supplementary grades of steel shall be determined by Ladle analysis and shall be as given in Tables 8b, 10b and 12b in this DEP.

7.2 PRODUCT ANALYSIS

Substitute first paragraph:

The product analysis shall comply as a base requirement with the limits given in Tables 8, (as amended by this DEP) 10 and 12. The chemical composition shall not be changed from that agreed by the Principal at the time of enquiry/order. For modified grades, the requirements of option B.8 shall apply. For supplementary grades the chemical composition shall comply with the limitations given in Tables 8b, 10b and 12b.

7.3 CARBON EQUIVALENT VALUE (CEV)

Modification to Table 1

For grades 355EM and 355EMZ the maximum carbon equivalent shall be 0.43% for thickness up to and including 150 mm.

7.4 MECHANICAL PROPERTIES

Addition:

Mechanical properties of supplementary steel grades shall be as given in Tables 9b, 11b and 13b.

CLAUSE 8 WELDABILITY DATA FOR MODIFIED GRADES

Substitute:

NOTE: Weldability data are only required for plates exceeding 40 mm in thickness and for rolled sections and seamless tubulars exceeding 20 mm in thickness.

At the time of the enquiry/order the Manufacturer shall provide data on the weldability of his material. Previously obtained data which the Manufacturer proposes to submit shall be verified by a competent third party, acceptable to the Principal, who witnessed the tests. The data presented shall bear the third party's stamp or seal. If the Manufacturer has carried out weldability testing for the Principal in accordance with option B.9, it will not be necessary to provide this data again. However, reference details of previous testing shall be provided to enable retrieval by the purchaser.

CLAUSE 9 QUALITY OF FINISHED STEEL

9.1 PLATES

9.1.1 Surface Condition

Addition:

The maximum allowable depth of plate edge defect shall not exceed 5 mm.

Where repair by grinding is carried out there shall be a blended transition to the unrepaired area, with a taper no steeper than 1:4.

9.1.3 Internal soundness for modified grades

Addition

Twin crystal probes are permitted for ultrasonic testing.

9.2 SECTIONS

9.2.2 Correction of minor defects

Addition:

Where repair by grinding is carried out there shall be a blended transition to the unrepaired area, with a taper no steeper than 1:4.

9.2.4 Internal Soundness for Modified Grades

Addition:

Twin crystal probes are permitted for ultrasonic testing.

9.3 SEAMLESS TUBULARS

9.3.3 Addition:

Where repair by grinding is carried out, there shall be a blended transition to the unrepaired area, with a taper no steeper than 1:4.

9.3.5 Addition:

The acceptance level for modified grades shall be BS 5996 quality grade L4. The use of twin crystal probes for ultrasonic testing is permitted.

CLAUSE 11 MARKING

11.1 DIE STAMP AND PAINT MARKING

11.1.1 General:

Addition:

The die stamp shall be located 150 mm from the trailing edge of the plate and 300 mm from the plate edge.

11.2 COLOUR CODING

Addition:

Grade 355C	Blue	Green
Grade 355CZ	Blue	Red
Grade 275C	Red	Green
Grade 275CZ	Red	White

SECTION TWO. SPECIFIC REQUIREMENTS FOR DIMENSIONAL AND SHAPE TOLERANCES

CLAUSE 15 TOLERANCES FOR PLATES

15.3 WIDTH TOLERANCE FOR PLATES

Modification:

A minus tolerance of 5 mm is allowed on the width.

CLAUSE 16 TOLERANCES FOR SECTIONS AND SEAMLESS TUBULARS

16.2 SEAMLESS TUBULARS

Modification of first paragraph:

The size, mass, length and straightness tolerances shall be as specified in BS 4848:Part 2 and shall also apply if the product is heat treated. Ends of seamless tubulars shall be supplied square cut. The tolerance on wall thickness shall be +15% and -5%.

SECTION THREE. SPECIFIC REQUIREMENTS FOR TESTING

CLAUSE 17 SELECTION AND IDENTIFICATION OF TEST SAMPLES FOR TENSILE AND IMPACT TESTS

17.2 CONDITION OF SAMPLES

17.2.2.1 Grades 355EM and 355EMZ

Addition:

Provided the Manufacturer can supply data verifying the adequate performance of his steel in the PWHT condition, the thickness above which testing in the simulated PWHT condition is required shall be increased, for plates and seamless tubulars, to 40 mm. The Manufacturer shall also provide data demonstrating the effect of extended times at the stress relieving temperature on the tensile properties (in case of the need for weld repairs after PWHT during fabrication, and subsequent re-heat treatment).

17.2.2.2 Grades 450EM and 450EMZ

Substitute first sentence:

For plates and seamless tubulars of thickness over 20 mm, the test samples shall be subjected to a simulated post-weld heat treatment at a temperature 25 °C below the tempering temperature shown on the test certificate.

CLAUSE 21 TENSILE TESTS

21.1 GENERAL

Addition:

The ratio of lower yield strength to tensile strength shall not exceed 0.85 for grades 275 and 355 steels, and shall not exceed 0.90 for grade 450 steel.

CLAUSE 24 IMPACT TEST PIECES

24.5 PLATES OF GENERAL AND MODIFIED GRADES

Substitute Clause (a)

(a) The sub-surface, as specified in 24.2 and 24.3 for all grades.

Substitute second paragraph:

Charpy V-notch test pieces shall be cut parallel to the principal direction of rolling for all general and supplementary grades, and transverse to the principal direction of rolling for all modified grades (see Figure 5 in BS 7191).

24.6 SECTIONS AND SEAMLESS TUBULARS

Substitute:

For seamless tubulars and general and supplementary section grades, Charpy V-notch test pieces shall be cut parallel to the principal forming direction. For modified section grades, Charpy V-notch test pieces shall be cut transverse to the principal forming direction.

CLAUSE 25 IMPACT TESTS

25.1 METHOD OF TESTING

Modification

The impact test shall be carried out in accordance with BS 131: Part 2 at the temperature given in Tables 9, 11 and 13 for the grade ordered.

25.5 STRAIN AGE TESTS FOR MODIFIED GRADES

Substitute:

Provided that the Manufacturer can supply information acceptable to the Principal, strain ageing impact tests shall not be required. Otherwise, testing in accordance with option B.23. shall be performed.

CLAUSE 26 THROUGH THICKNESS TESTING FOR Z GRADES

Substitute:

Provided that the Manufacturer can supply sufficient information acceptable to the Principal, and guarantee that the steel meets the requirements of option B.24., through thickness testing will not be required. Otherwise option B.24 shall be applied.

CLAUSE 27 RETESTS

Addition:

Should a tensile or Charpy test result fail to meet the requirements of BS 7191 then:

(1) Retesting without re-heat treatment will only be allowed subject to the conditions of clauses 27.1 and 27.2.

(2) For normalised and quenched and tempered steels, if the conditions in (1) above are not fulfilled, re-heat treatment shall be performed prior to any further testing. For TMCR steels, the product shall be rejected.

27.1 TENSILE TESTS

Substitute first paragraph:

Should a test result not comply with clause 21 and provided that the failed result is greater than or equal to 97% of the specified minimum value, two further test pieces may be made on samples taken from the product from which the original test piece was prepared. Otherwise the product from which the test samples were taken shall be rejected.

SECTION FOUR. SPECIFIC REQUIREMENTS FOR THE CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES OF WELDABLE STRUCTURAL STEEL PLATES

CLAUSE 29 GENERAL

Table 8. Chemical Composition for Plates

Modification

See modified table 8.

Table 8b. Chemical Composition for Plates - Supplementary Grades

Addition

See new table 8b.

Table 9. Mechanical Properties for Plates Modification

See modified table 9.

Table 9b. Mechanical Properties for Plates - Supplementary Grades

Addition

See new table 9b.

Table 8 Chemical Composition for Plates

	Chemical Composition (1)																	
Grade	C Max	Si	Mn	S max.	P max.	Cr max.	Mo max.	Nb	V	Ti max.	Ni max. (7)	Cu max.	Al (total) max. (8)	N max. (8)	Cr+Mo+ Ni+Cu max.	Nb+V max.	Nb+ V+Ti max.	Carbon Equiv max.	Normal supply condition
	%	%	%	%	%	%	%	%	%	%	%	%	%	%		%	%	%	(2)
275D (3)	0.16	0.50 max	1.5 max	0.040	0.040	-	-	0.003/0.10	0.015 max.	-	-	-	-	-	-	0.10	-	0.41	N
275E	0.16	0.10/0.50	1.5 max	0.030	0.040	-	-	-	-	-	-	-	-	-	-	-	-	0.39	N
275EZ	0.16	0.10/0.50	1.5 max	0.008	0.025	-	-	-	-	-	-	-	-	-	-	-	-	0.39	N
355D (3, 5)	0.16	0.10/0.50	1.5 max	0.040	0.040	-	-	0.003/0.10	0.015 max.	-	-	-	-	-	-	0.10	-	0.43	N
355E (3, 5)	0.16	0.10/0.50	1.5 max	0.030	0.040	-	-	0.003/0.10	0.015 max.	-	-	-	-	-	-	0.10	-	0.43	N
355EM (6)	0.15	0.25/0.55	1.00/1.65	0.015	0.025	0.08	0.08	0.04 max.	0.015 max.	0.02	0.55	0.30	0.055	0.01	0.80	-	-	0.43	N
355EMZ (6)	0.15	0.25/0.55	1.00/1.65	0.008	0.025	0.08	0.08	0.04 max.	0.015 max.	0.02	0.55	0.30	0.055	0.01	0.80	-	-	0.43	N
450EM (6)	0.16	0.25/0.55	1.00/1.65	0.015	0.025	0.30	0.25	0.03 max.	0.08 max.	0.02	0.65	0.30	0.055	0.01	0.80	0.095	0.11	0.43	QT
450EMZ (6)	0.16	0.25/0.55	1.00/1.65	0.008	0.025	0.30	0.25	0.03 max	0.08 max. (9)	0.02	0.65	0.30	0.055	0.01	0.80	0.095	0.11	0.43	QT

(1) The chemical compositions apply to the following:
(a) Ladle only in the case of grades 275D, 275E, 275EZ, 355D and 355E and
(b) Ladle and product in the case of grades 355EM, 355EMZ, 450EM and 450EMZ.

(2) For alternative supply conditions see clause 6.

(3) Steels may be supplied with no niobium or vanadium. If grain refining elements other than aluminium, niobium or vanadium are used, the manufacturer shall inform the purchaser at the time of enquiry and order.

(4) For grades 355D and 355E over 16 mm thick, a maximum carbon content of 0.20% for ladle is permitted.

(5) The carbon and manganese contents may be varied (ladle analysis) for grades 355D and 355E on the basis of an increase of 0.06% manganese content for each decrease of 0.01% carbon or vice versa up to a maximum manganese content of 1.60% and a maximum carbon content of 0.20%.

(6) The levels of the residual elements arsenic, antimony, tin, lead, bismuth and calcium shall not exceed 0.02% for As, 0.010% for Sb, 0.015% for Sn, and 0.005% for Pb, Bi and Ca. Boron (B) shall not exceed 0.0005%.
These elements shall be reported as a ladle analysis and shall be checked once every 5000 t at each manufacturing location.

(7) Grades 355EM and 355EMZ over 40 mm shall contain at least 0.25% Nickel.

(8) The soluble aluminium to nitrogen ratio shall be a minimum of 2:1.Soluble aluminium content is defined as 0.005% less than the total aluminium content.

(9) Grades 450EM and 450EMZ which are alloyed with vanadium shall not contain more than 0.015% Niobium.

Table 8b Chemical Composition for Plates - Supplementary Grades

Grade	Chemical Composition (1)									
	C max	Si	Mn	S max	P max	Nb	V	Nb + V max	Carbon equivalent	Normal supply condition (2)
	%	%	%	%	%	%	%	%		
275C	0.20	0.50 max	1.5 max	0.040	0.040	-	-	-	0.41	AR or N
275CZ	0.20	0.50 max	1.5 max	0.008	0.025	-	-	-	0.41	N
355C (3)	0.20 (4)	0.10/0.50	1.5 max	0.040	0.040	0.003/0.10	0.015 max	0.10	0.43	N
355CZ (3)	0.20 (4)	0.10/0.50	1.5 max	0.008	0.025	0.003/0.10	0.015 max	0.10	0.43	N

(1) The chemical analysis applies to ladle analysis.

(2) For alternative supply condition, see clause 6 of BS 7191.

(3) If no grain refining elements, or if grain refining elements other than aluminium, niobium or vanadium are used, the manufacturer shall inform the purchaser at the time of enquiry and order.

(4) The carbon and manganese contents may be varied for grades 355C and 355CZ on the basis of an increase of 0.06% manganese for each decrease of 0.01% or vice versa up to a maximum manganese content of 1.60% and a maximum carbon content of 0.20%.

Table 9 Mechanical Properties for Plates

Tensile strength R_m (1) (6)	Yield strength, R_e, for thickness (in mm) (6)						Minimum elongation, A, on gauge length of: (1)			Minimum average Charpy V-notch impact test value (2)			Grade
	Up to and including 16	Over 16 up to and including 40	Over 40 up to and including 63	Over 63 up to and including 100	Over 100 up to and including 120	Over 120 up to and including 160	80 mm (3)	200 mm (4)	5.65 $\sqrt{S_o}$	Temp.	Energy min. value	Thickness	
N/mm^2	N/mm^2 (5)	N/mm^2	N/mm^2	N/mm^2	N/mm^2	N/mm^2	%	%	%	°C	J	mm	
430/580	275 min	265 min	-	-	-	-	23	20	22	-20	40	40	275D
430/580	275 min	265 min	-	-	-	-	23	20	22	-40	40	40	275E
430/580	275 min	265 min	-	-	-	-	23	20	22	-40	40	40	275EZ
490/640	355/455	345/445	-	-	-	-	20	18	20	-20	50	40	355D
490/640	355/455	345/445	-	-	-	-	20	18	20	-40	50	40	355E
460/620	355/455	345/445	340/445	325/445	315/445	305/445	20	18	20	-40	50	150	355EM
460/620	355/455	345/445	340/445	325/445	315/445	305/445	20	18	20	-40	50	150	355EMZ
	Up to and including 16	Over 16 up to and including 25	Over 25 up to and including 75										
550/700	450/550	430/530	415/515	-	-	-	19	17	19	-40	60	75	450EM
550/700	450/550	430/530	415/515	-	-	-	19	17	19	-40	60	75	450EMZ

(1) The tensile strength and elongation values apply up to the maximum thickness for which the yield strengthvalues are specified.

(2) For the Charpy V-notch test, mid-thickness tests are also required when thickness is over 40 mm.

(3) Up to and including 9 mm thick: 17% for grades 275D, 275E and 275EZ, and
16% for grades 355D, 355E, 355EM, 355EMZ, 450EM and 450EMZ.

(4) Up to and including 9 mm thick: 16% for grades 275D, 275E, and
15% for grades 355D, 355E, 355EM, 355EMZ, 450EM and 450EMZ.

(5) 1 Nmm^2 = 1 MPa

(6) Unless indicated as a minimum value, the values given indicate the permissible range.

Table 9b Mechanical Properties for Plates - Supplementary Grades

Tensile Strength R_m (1) (4)	Yield Strength, R_e, for thickness (in mm) (4)					Minimum elongation, A, on gauge length of: (1)			Minimum average Charpy V-notch impact test value			Grade
	Up to and including 16	Over 16 up to and including 40	Over 40 up to and including 63	Over 63 up to and including 100	Over 100 up to and including 120	80 mm (2)	200 mm	$5.65\sqrt{S_o}$	Temp.	Energy Min. Value	Thickness	
N/mm^2	N/mm^2 (3)	N/mm^2	N/mm^2	N/mm^2	N/mm^2	%	%	%	°C	J	mm	
430/580	275 min	265 min	-	-	-	23	20	22	0	40	40	275C
430/580	275 min	265 min	-	-	-	23	20	22	0	40	40	275CZ
490/640	355/455	345/445	340/445	325/445	315/445	20	18	20	0	50	120	355C
490/640	355/455	345/445	340/445	325/445	315/445	20	18	20	0	50	120	355CZ

(1) The tensile strength and elongation values apply up to the maximum thickness for which the yield strength values are specified.

(2) Up to and including 9mm thick: 17% for grades 275C and 275CZ, and
16% for grades 355C and 355CZ.

(3) 1 N/mm^2 = MPa.

(4) Unless specified as a minimum value, the values given indicate the permissible range.

SECTION FIVE. SPECIFIC REQUIREMENTS FOR THE CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES OF WELDABLE STRUCTURAL STEEL SECTIONS

CLAUSE 30 GENERAL

Table 10b. Chemical Composition for Sections - Supplementary Grades

Addition

See new table 10b.

Table 11. Mechanical Properties for Sections

Modification

Add 265 min to column "over 20 up to and including 40" for grade 275D.

Table 11b. Mechanical Properties for Sections - Supplementary Grades

Addition

See new table 11b.

Table 10b Chemical Composition for Sections - Supplementary Grades

Grade	Chemical composition (1)									
	C max	Si	Mn	S max	P max	Nb	V	N_b + V max	Carbon equivalent	Normal supply condition
	%	%	%	%	%	%	%	%		
275C	0.16	0.50 max	1.5	0.040	0.040	-	-	-	0.41	N
355C (2)	0.18 (3)	0.10/0.50	1.5 (4)	0.040	0.040	0.003/0.10	0.015 max	0.10	0.43	N
355CZ (2)	0.18 (3)	0.10/0.50	1.5 (4)	0.008	0.025	0.003/0.10	0.015 max	0.10	0.43	N

(1) The chemical compositions apply to ladle analysis.

(2) If no grain refining elements, or if grain refining elements other than aluminium, niobium or vanadium are used, the manufacturer shall inform the purchaser at the time of enquiry and order.

(3) For grades 355C and 355CZ over 16 mm thick, a maximum carbon content of 0.20% is permitted.

(4) The carbon and manganese contents may be varied for grades 355C and 355CZ on the basis of an increase of 0.06% manganese for each decrease of 0.01% carbon or vice versa up to a maximum manganese content of 1.60% and a maximum carbon content of 0.20%.

Table 11b Mechanical Properties for Sections - Supplementary Grades

Tensile strength R_m (3)	Yield strength, R_e, for thickness (in mm) (3)		Minimum elongation, A, on gauge length of		Min Average Charpy impact test value		Grade
	Up to and including 16	Over 16 up to and including 40	200 mm (1)	$5.65\sqrt{S_o}$	Temp.	Energy min value	
N/mm^2 (2)	N/mm^2	N/mm^2	%	%	°C	J	
430/580	275 min	265 min	20	22	0	40	275C
490/640	355/455	345/445	18	20	0	50	355C
490/640	355/455	345/445	18	20	0	50	355CZ

(1) Up to and including 9 mm thick: 16% for grade 275C, and 15% for grade 355C, 355CZ.

(2) 1 N/mm^2 = 1 MPa

(3) Unless specified as a minimum value, the values given indicate the permissible range.

SECTION SIX SPECIFIC REQUIREMENTS FOR THE CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES OF WELDABLE STRUCTURAL STEEL SEAMLESS TUBULARS

CLAUSE 31 GENERAL

Table12b. Chemical Composition for Seamless Tubulars - Supplementary Grades

Addition

See new table 12b.

Table 13. Mechanical Properties for Seamless Tubulars

Modification

Add 265 min to column "over 20 up to and including 40" for grade 275D.

Table 13b. Mechanical Properties for Seamless Tubulars - Supplementary Grades

Addition

See new table 13b.

Table 12b Chemical Composition for Seamless Tubulars - Supplementary Grades

Grade	Chemical Composition (1)									
	C max.	Si	Mn max.	S max.	P max.	Nb	V	Nb + V max.	Carbon equivalent	Normal supply condition
	%	%	%	%	%	%	%	%		
275C	0.16	0.50 max	1.5	0.040	0.040	-	-	0.10	0.41	N
355C (2)	0.18 (3)	0.10/0.50	1.5 (4)	0.040	0.040	0.05 max.	0.015 max.	0.10	0.43	N

(1) The chemical compositions apply to the ladle analysis.

(2) If no grain refining elements, or if grain refining elements other than aluminium, niobium or vanadium are used, the manufacturer shall inform the purchaser at the time of enquiry and order.

(3) For grades 355C over 16 m thick, a maximum carbon content of 0.20% is permitted.

(4) The carbon and manganese contents may be varied for grades 355C on the basis of an increase of 0.06% manganese for each decrease of 0.01% carbon or vice versa to a maximum manganese content of 1.60% and a maximum carbon content of 0.20%.

Table 13b Mechanical Properties for Seamless Tubular - Supplementary Grades

Tensile strength R_m (3)	Yield strength, R_e, for thickness (in mm) (3)		Minimum elongation, A, on gauge length of		Min average Charpy impact test value		Grade
	Up to and including 16	Over 16 up to and including 40	200 mm (1)	$5.65\sqrt{S_o}$	Temp.	Energy min value	
N/mm^2 (2)	N/mm^2	N/mm^2	%	%	°C	J	
430/580	275 min	265 min	20	22	0	27	275C
490/640	355/455	345/445	18	20	0	36	355C

(1) Up to and including 9 mm thick: 16% for grade 275C, and 15% for grade 355C.

(2) 1 N/mm^2 = 1 MPa.

(3) Unless specified as a minimum value, the values given indicate the permissible range.

APPENDIX B OPTIONS

B.9 WELDABILITY TESTS

B.9.1 Selection of weldability tests

Substitute:

Weldability testing shall be performed by means of the series of tests described in Appendix F.

APPENDIX F WELDABILITY TESTING FOR MODIFIED GRADES AND MECHANICAL TESTING OF BUTT WELDS

F.2 WELDING PROCEDURE

Substitute:

The Manufacturer shall submit detailed welding procedures for review and approval by the Principal at least three weeks prior to commencement of welding. The procedures shall include wire or electrode size, welding parameters, welding position and other relevant parameters, e.g. number of SAW wires and bevel angles.

Only welding consumables which have previously demonstrated consistently high CTOD values (i.e. above 0.25 mm) at the nominated minimum design temperature shall be used.

F.3 PLATE BUTT-WELD REQUIREMENTS

F.3.1 Test plate dimensions

Substitute first sentence.

The test plate thickness shall correspond to the maximum thickness of plates to be supplied from concast and ingot routes (see Table 21 with amendments).

F.3.2 Bevel Detail

Delete last sentence.

F.3.4 Nominal Arc Energy

Delete

the requirement for SAW, 3.0 kJ/mm.

Substitute

FCAW, 0.8 kJ/mm for FCAW, 0.6 kJ/mm.

F.3.5 Heat Treatment

Substitute second paragraph:

For grade 450 test welds, post-weld heat treatment shall be performed at a temperature 25 °C below the tempering temperature shown on the test certificate, for either 1 hour per 25 mm thickness of plate or 4 hours, whichever is greater.

F.4 MECHANICAL TESTING

F.4.1 General

Modification of first sentence:

A series of mechanical tests shall be carried out in accordance with Table 22, as amended by this DEP.

F.4.2 Charpy V-notch Impact tests

Delete the third paragraph.

F.4.3.2 Test Requirements Note (a) Grain-coarsened HAZ.

Substitute:

To be considered a valid test, the fatigue crack should be within 0.5 mm of the fusion line and should be located so as to maximise the amount of grain coarsened HAZ sampled.

F.4.3.4 Additional COD tests

Delete this clause.

F.5 SPECIFIC TEST REQUIREMENTS

F.5.1 Tests in the as-welded and PWHT conditions

Modification

as welded	PWT
$40 < t \leq 70$ mm concast	$40 < t \leq 70$ mm concast
$40 < t \leq 150$ mm ingot	$40 < t \leq 150$ mm ingot

F.5.1(c) Vickers Hardness

Modification

Vickers hardness shall be 325 Hv10 max., except in the case of 0.8 KJ/mm arc energy when the value shall be 350 Hv10 max.

Appendix F Table 21 Weldability test requirements for butt welds

Grade, type and maximum thickness range t (mm)	Condition	Nominal arc energies (kJ/mm)		
		FCAW 0.8	SAW 5.0	SAW 3.5
		P = 125 °C *I* = 250 °C (3)	*P* = 125 °C *I* = 250 °C	*P* = 125 °C *I* = 250 °C
355 EMZ				
40 < t ≤ 70 concast	As welded	Yes	Yes	(1)
40 < t ≤ 70 concast	PWHT	Yes	Yes	(1)
40 < t ≤ 150 ingot	As welded	Yes	Yes	(1)
40 < t ≤ 150 ingot	PWHT	Yes	Yes	(1)
450 EMZ				
40 < t ≤ 75 ingot or concast	As welded	No	(2)	Yes
40 < t ≤ 75 ingot or concast	PWHT	No	(2)	Yes
Tubulars and sections (4)				
25 < t ≤ 40	As welded	Yes	(2)	Yes

P is the minimum pre-heat temperature (in °C)
I is the maximum interpass temperature (in °C).

(1) Grade 355 EMZ tests may also be required at 3.5 kJ/mm if tests at 5.0 kJ/mm produce results below the purchaser's acceptance criteria.

(2) Not normally weldable. However, if the Manufacturer tests at SAW, 5.0 kJ/mm this will also qualify for SAW, 3.5 kJ/mm.

(3) For CEV = 0.43, use *P* = 150 °C.

(4) See option B.9.1.

Appendix F Table 22 - Mechanical test requirements for each butt weld

Type of test	Number of tests	Position of tests (1)	Acceptance criteria
Macro/hardness	2	See F.4.4 and Figure 12	325 Hv10, except for 0.8 kJ/m arc energy when acceptance value is 350 Hv10 (see F.5.1(c))
Charpy V-notch	One set of 3 tests per position	Position of tests as follows:	Tested at -40 °C to meet the following:
		(a) Transverse to rolling direction. (b) At FL, FL+2 and FL+5 on specimens from cap, mid-thickness and root from both straight edge and bevel edges (see F.4.2, F.5.1 (a) and Figure 11).	(a) For grade 355, a minimum average of 36 J and a minimum individual value of 26 J; (b) For grade 450, a minimum average of 45 J and a minimum individual value of 32 J.
CTOD	3 tests per position	Position of tests as follows:	Tested at -10 °C to meet the specified minimum CTOD value.
		(a) Transverse to rolling directions (b) At each of the following positions: 1. GCHAZ 2. SCHAZ/ICHAZ boundary 3. Weld metal	

(1) For details of butt welds, see F.3 and Table 21 (as amended by this DEP).

PART IV 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 publications listed at the end of BS 7191 remain applicable after amendment by this DEP.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.

BRITISH STANDARDS

Weldable structural steels for fixed offshore structures	BS 7191 (1989), including amendments AMD 6750 and AMD 6885

Issued by:
British Standards Institution
2 Park Street
London W1A 2BS
England.

PART V BIBLIOGRAPHY

The following publication, EEMUA 150, is not considered an integral part of this DEP and is not required to be consulted in order to comply with this DEP. Nevertheless,
BS 7191 was derived from this publication and provides, where necessary for the reader, useful additional information:

Steel Specification for Fixed Offshore Structures EEMUA 150
(Adapted for Offshore from BS 4360:1986)

Issued by:
The Engineering Equipment and Materials Users Association
14-15 Belgrave Square
London SW1X 8PS
England.

APPENDICES

APPENDIX 1 DESCRIPTION OF TERMINOLOGY FOR STEEL GRADES

The terminology used in this DEP for naming of steel grades, including supplementary steel grades, follows that used in BS 7191. An example of the terminology used is given below. For grade 355EMZ as an example:

355	E	M	Z
355 denotes that the steel has a specified minimum yield strength of 355 N/mm^2 for thicknesses below 16 mm.	**E** denotes that the steel shall be impact tested at -40 °C	**M** denotes that the steel is a modified grade	**Z** denotes that the steel is supplied with guaranteed through thickness properties

APPENDIX 2 BASIS FOR THE SUPPLEMENTARY STEEL GRADES

The chemical and mechanical requirements for the supplementary grades of steel listed in Tables 8b, 9b, 10b, 11b, 12b and 13b of this DEP are based on grades existing in other standards. A summary is given in Table A1. It should be noted that Table A1 is given for information only. The general requirements for supply of supplementary steel grades are, however, in accordance with BS7191 unless specifically modified within the text of this DEP.

Table A1. Steel Grades Forming the basis for Supplementary Grades

Grade in this Specification	Basis for new grade
275C	BS 4360-43C
275CZ	BS 4360-43C
355C	BS 4360-50C
355CZ	BS 4360-50C