

DEP SPECIFICATION

STRUCTURAL WELDING AND INSPECTION OF DEEPWATER FLOATING PRODUCTION SYSTEMS (AMENDMENTS/SUPPLEMENTS TO AWS D1.1/D1.1M:2008)

DEP 37.81.10.33-Gen.

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DESIGN AND ENGINEERING PRACTICE



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TABLE OF CONTENTS

PART I	INTRODUCTION AND GENERAL REQUIREMENTS	6
1	INTRODUCTION	6
1.1	SCOPE	6
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	6
1.3	DEFINITIONS	6
1.4	UNITS	7
1.5	DOCUMENTS REQUIRING SUBMITTAL	7
1.6	CROSS-REFERENCES	7
1.7	COMMENTS ON THIS DEP	8
2	GENERAL REQUIREMENTS	9
2.1	GENERAL	9
2.2	CONTRACTOR'S QUALITY SYSTEM	9
2.3	CONTRACTOR'S STANDARD PRACTICES	9
PART II	AMENDMENTS/SUPPLEMENTS TO AWS D1.1/D1.1M:2008	10
1.1	SCOPE	10
1.4	RESPONSIBILITIES	10
2	DESIGN OF WELDED CONNECTIONS	11
2.2	CONTRACT PLANS AND SPECIFICATIONS	11
2.3	EFFECTIVE AREAS	12
2.6	JOINT CONFIGURATION AND DETAILS	12
2.7	JOINT CONFIGURATION AND DETAILS – GROOVE WELDS	12
2.8	JOINT CONFIGURATION AND DETAILS – FILLET WELDED JOINTS	12
2.10	FILLER PLATES:	12
2.11	BUILT-UP MEMBERS	13
2.16	DETAILING, FABRICATION AND ERECTION	13
2.17	PROHIBITED JOINTS AND WELDS	13
2.20	ALLOWABLE STRESSES	13
2.23	WELD DESIGN	13
2.24	LIMITATIONS OF THE STRENGTH OF WELDED CONNECTIONS	14
2.25	THICKNESS TRANSITION	14
2.26	MATERIAL LIMITATIONS	14
3	PREQUALIFICATION OF WPS	15
3.1	SCOPE	15
3.3	BASE METAL/FILLER METAL COMBINATIONS	15
3.11	COMMON REQUIREMENTS OF PJP AND CJP GROOVE WELDS	15
3.12	PJP REQUIREMENTS	15
3.13	CJP GROOVE WELD REQUIREMENTS	15
3.14	POST WELD HEAT TREATMENT	16
4	QUALIFICATION	16
4.1	GENERAL	17
4.5	WELD TYPES FOR WPS QUALIFICATION	18
4.6	PREPARATION OF WPS	18
4.7	ESSENTIAL VARIABLES	19
4.8	METHODS OF TESTING AND ACCEPTANCE CRITERIA FOR WPS QUALIFICATION	23
4.9	CJP GROOVE WELDS FOR NONTUBULAR CONNECTIONS	26
4.10	PJP GROOVE WELDS FOR NONTUBULAR CONNECTIONS	27
4.12	CJP GROOVE WELDS FOR TUBULAR CONNECTIONS	27
4.13	PJP TUBULAR T-, Y-, OR K-CONNECTIONS AND BUTT JOINTS	27
4.15	WELDING PROCESSES REQUIRING QUALIFICATION	27
4.17	WPS REQUIREMENTS (ESW/EGW)	27
4.18	GENERAL	27

4.20	WELD TYPES FOR WELDER AND WELDING OPERATOR PERFORMANCE	
	QUALIFICATION	28
4.21	PREPARATION OF PERFORMANCE QUALIFICATIONS FORMS	28
4.22	ESSENTIAL VARIABLES	29
4.23	CJP GROOVE WELDS FOR NONTUBULAR CONNECTIONS	29
4.26	CJP GROOVE WELDS FOR TUBULAR CONNECTIONS	29
4.33	GENERAL	29
4.34	TEST LOCATIONS	29
4.35	CVN TESTS	30
4.36	TEST REQUIREMENTS	30
5.	FABRICATION	31
5.2	BASE METAL	31
5.3	WELDING CONSUMABLES AND ELECTRODE REQUIREMENTS	31
5.4	ESW AND EGW PROCESSES	33
5.5	WPS VARIABLES	34
5.6	PREHEAT AND INTERPASS TEMPERATURE	34
5.8	STRESS RELIEF HEAT TREATMENT	34
5.9	BACKING, BACKING GAS, OR INSERTS	34
5.10	BACKING	35
5.13	CONFORMANCE WITH DESIGN	35
5.14	MINIMUM FILLET WELD SIZE	36
5.15	PREPARATION OF BASE METALS	36
5.17	BEAM COPIES AND WELD ACCESS HOLES	37
5.18	TACK WELDS AND CONSTRUCTION AID WELDS	37
5.19	CAMBER IN BUILT-UP MEMBERS	37
5.20	SPICES IN CYCLICALLY LOADED STRUCTURES	38
5.21	CONTROL DISTORTION AND SHRINKAGE	38
5.22	TOLERANCE OF JOINT DIMENSIONS	38
5.23	DIMENSIONAL TOLERANCES OF WELDED STRUCTURAL MEMBERS	39
5.24	WELD PROFILES	39
5.26	REPAIRS	39
5.27	PEENING	40
5.28	CAULKING	40
5.29	ARC STRIKES	40
5.30	WELD CLEANING	41
5.31	WELD TABS	41
5.32	STRAY CURRENT CONTROL	41
6.	INSPECTION	41
6.1	SCOPE	42
6.2	INSPECTION OF MATERIALS AND EQUIPMENT	42
6.3	INSPECTION OF WPS	43
6.5	INSPECTION OF WORK AND RECORDS	44
6.6	OBLIGATIONS OF THE CONTRACTOR	45
6.7	SCOPE	45
6.9	VISUAL INSPECTION	45
6.11	NDT	46
6.12	RT	47
6.13	UT	47
6.14	PROCEDURES	48
6.16	RT OF GROOVE WELDS IN BUTT JOINTS	49
6.17	RT PROCEDURES	49
6.18	SUPPLEMENTARY RT REQUIREMENTS FOR TUBULAR CONNECTIONS	49
6.19	EXAMINATION, REPORT AND DISPOSITION OF RADIOGRAPHS	49
7.0	STUD WELDING	50
7.6	STUD APPLICATION QUALIFICATION REQUIREMENTS	51
7.9	MANUFACTURER'S STUD BASE QUALIFICATION REQUIREMENTS	51
8.0	STRENGTHENING AND REPAIRING EXISTING STRUCTURES	51

TABLES AND FIGURES 52

**APPENDIX A4.7.1 SPECIAL REQUIREMENTS FOR GMAW-S WELDING OF
STRUCTURAL STEEL 63**

APPENDIX A4.7.6 HEAT INPUT RANGES 67

**APPENDIX A4.8.7 CTOD TESTING REQUIREMENTS FOR WELDING PROCEDURE
QUALIFICATION 69**

PART III REFERENCES 76

PART I INTRODUCTION AND GENERAL REQUIREMENTS

1 INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements for the structural welding, welding procedure qualification, welder qualification, visual and non-destructive examination, and the corresponding material applications for Floating Production System (FPS) hulls and decks.

This DEP is based on the American Welding Society, Structural Welding Code – Steel, AWS D1.1/D1.1M:2008, herein referred to as AWS D1.1. Part II of this DEP is written as amendments and supplements to AWS D1.1.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in deepwater offshore oil and gas drilling and production floating hull and topsides structures including Tension Leg Platforms, Semisubmersibles and Spars but excluding ship shaped hulls.

When DEPs are applied, a Management of Change (MOC) process should be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could 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 with regards to the 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, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

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

The **Principal** is the party that initiates the project and ultimately pays for it. 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

Definitions are included in contract documents and as follows:

“Accept” shall mean the Principal’s written acceptance of the submitted document.

“Approve” shall mean the Principal’s written approval of the submitted document which shall be completed prior to ordering materials and/or beginning the Work.

“Clause” refers to a portion(s) of AWS D1.1 or portion(s) of this DEP that includes a modification to an AWS Clause.

"Contract" shall mean the specific agreement between the Principal and the Contractor containing commercial terms and conditions.

"Drawings" shall mean Principal furnished drawings, spreadsheets, databases or data files and revisions thereof. Drawings may be in the form of summary Drawings, typical details, notes and rules from which the Contractor shall develop the necessary shop and erection drawings.

"Paragraph" refers to a portion of the referenced applicable document.

"Review" shall mean Principal's right, but not obligation, to review and comment on the submitted document.

"Section" refers to a portion of this DEP unless specifically combined with a reference standard (e.g. API RP 2A Section 6).

Throughout this DEP reference is made to the following:

"Critical Steel" shall mean steel designated as Critical on the Drawings.

"Special Steel" shall mean steel designated as Special on the Drawings.

"Primary Steel" shall mean steel designated as Primary on the Drawings.

"Secondary Steel" shall mean steel designated as Secondary on the Drawings.

"Tertiary Steel" shall mean steel designated as Tertiary on the Drawings.

"Work" shall mean any portion of engineering, procurement, manufacturing, fabrication, welding, inspection, coating and all other activities identified in the Contract.

"Zone(s)" - these Zones (e.g. Zones 1, 1A, 1F, 2 and 3) are zones of structural criticality and are identified on drawings. Within this DEP, inspection techniques, acceptance criteria and extent of coverage are designated by Zone.

1.4 UNITS

Reference is made to the American Welding Society, Structural Welding Code Steel, AWS D1.1/D1.1M. This AWS standard makes use of both U.S. Customary Units, designated therein as D1.1 and the International System of Units (SI), designated therein as D1.1M. When the term D1.1 is used in this DEP it shall mean either D1.1 or D1.1M dependent on the system of units selected for use by the Contractor to perform the Work.

As per the provisions of AWS D1.1, Clause 1.8, each measurement system shall be used independently of the other without combining in any way.

This DEP utilizes both the International System of Units (SI) and U.S. Customary Units which are shown in parenthesis behind the International System of Units (SI).

Applicable Documents may specify the system of units to be used for particular test preparations, measurements and/or reporting, in which case, the specified units shall be used.

1.5 DOCUMENTS REQUIRING SUBMITTAL

The Contractor shall submit 2 copies of the documentation as indicated throughout this DEP and as summarized in Table 1.5. The submittal timing and the Principal's action (e.g. Approve, Accept or Review) that will be taken relative to the submitted document, are included in Table 1.5.

1.6 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 III).

1.7 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of “DEPs on the Web”, available through the Global Technical Standards web portal <http://www.shell.com/standards> and on the main page of the DEPs DVD-ROM.

2 GENERAL REQUIREMENTS

2.1 GENERAL

Part II of this DEP amends, supplements and deletes various clauses/paragraphs of AWS D1.1/D1.1M:2008. Wherever reference is made to AWS D1.1, it shall be understood to mean AWS D1.1/D1.1M:2008 as amended/supplemented by this DEP.

For ease of reference, the clause numbering of AWS D1.1 has been used throughout Part II of this DEP. Only those clauses with clarifications, modifications, deletions and additions are included herein. Clauses of AWS D1.1 that are not mentioned in this DEP shall remain applicable as written.

Qualification of structural welding and personnel shall be in accordance with AWS D1.1, as modified by this DEP.

2.2 CONTRACTOR'S QUALITY SYSTEM

The Contractor's quality management system shall comply with and be certified to ISO 9001.

2.3 CONTRACTOR'S STANDARD PRACTICES

The Contractor's standard practices that exceed the requirements of this DEP shall be applicable.

PART II AMENDMENTS/SUPPLEMENTS TO AWS D1.1/D1.1M:2008**1.1 SCOPE**

Add the following:

In cases where there is a conflict between Clause narratives, Tables or Figures, the most stringent requirement shall apply.

1.4 RESPONSIBILITIES**1.4.1 Engineers Responsibilities**

Add the following.

- 1.4.1(1): All AWS code requirements are required and shall be considered specified by the Engineer. Codes that apply in addition to AWS D1.1 are identified in Section 9, Applicable Documents and in the contract.
- 1.4.1(2): The applicable AWS and other code Non Destructive Testing (NDT) methods and requirements, including progressive inspection protocol shall be according to Section 6. The extent and required minimum percentages of NDT by method and weld type shall be as specified in the Drawings.
- 1.4.1(3): All verification inspections identified in AWS are required by the Engineer. Additional verification inspections shall be performed for materials, processes, procedures and final products in accordance with this DEP and the Drawings.
- 1.4.1(4): Weld inspection criteria in addition to AWS Clause 6 shall be in accordance with this DEP and the Drawings.
- 1.4.1(5): The Charpy V-Notch (CVN) toughness test criteria and requirements, percent shear evaluation, Crack Tip Opening Displacement (CTOD), drop-weight and other base metal, weld metal, fusion line and Heat Affected Zone (HAZ) testing shall be per this DEP and the Drawings. The Lowest Anticipated Service Temperature (i.e. LAST) shall be as specified in the Drawings.
- 1.4.1(6): Floating Production Systems, including all portions of hulls, decks and modules built to this DEP shall be considered to be "Cyclically Loaded". As such, the "Cyclically Loaded" provisions within AWS shall always be selected in lieu of alternative provisions for "Statically Loaded" components.
- 1.4.1(7): This DEP and the Drawings contain requirements in addition to those in AWS. The Engineer acknowledges that in some cases, the requirements in this DEP and the Drawings are similar to those in AWS but are more stringent.
- 1.4.1(8): As specified in this DEP and as used within AWS context, the Contractor is not considered an Original Equipment Manufacturer (OEM). The Contractor assumes no responsibilities of the Engineer. The Engineer is a duly designated individual who acts for, and on behalf of the Principal.

2 DESIGN OF WELDED CONNECTIONS

Part A Common Requirements for Design of Welded Connections (Nontubular and Tubular Members)

2.2 CONTRACT PLANS AND SPECIFICATIONS

Clarify and add the following:

2.2.2 Notch Toughness Requirements

Special mechanical and chemical testing requirements shall be as specified in this DEP and on the Drawings.

2.2.3 Specific Welding Requirements

Specific assembly order, welding sequence, verification hold-points and special precautions shall be as specified in this DEP, on the Drawings and in the Contractor's Approved Inspection and Test Plan. The Principal's omission of requirements does not relieve the Contractor of the basic responsibilities to meet this DEP. As an example, the Contractor is solely responsible for distortion, NDT completion, decisions that limit access for welding, NDT, etc., regardless of the Principal's omissions relative to specifying assembly order, weld sequence, etc.

2.2.4 Weld Size and Length:

2.2.4(1): Fillet weld leg sizes shown on the Drawings are those associated with two surfaces that nominally intersect at 90 degrees. For parts that intersect with angles between 85 to 95 degrees inclusive, the fillet leg lengths shown on the Drawings shall apply.

2.2.4(2): Fillet weld leg sizes shown on the Drawings are those associated with two surfaces that nominally intersect at 90 degrees. For the sides of components that intersect with angles greater than 95 degrees and less than or equal to 135 degrees, the fillet weld leg length shown on the Drawing shall be increased by the factors shown in AWS Annex B. For the sides of components that intersect between 60 and 84 degrees the fillet weld leg length shown on the Drawing shall apply and for the sides of components that intersect at angles less than 60 degrees the Z-Loss dimension shown in AWS Table 2.2 shall be added to the fillet weld leg length.

2.2.5 Shop Drawing Requirements

2.2.5.3 Welding Symbols

Welds shown on the Drawings with groove weld symbols, including any of the 11 groove types shown in AWS, "Legend for Figures 3.3 and 3.4", with no dimensions and without the designation CJP shown in the tail shall be Complete Joint Penetration (CJP) welds. All CJP welds shall be backgouged and backwelded unless specifically noted otherwise on the Drawings.

2.2.5.5 Special Details

Groove details shall be as specified in this DEP and on the Drawings.

2.2.5.6 Specific Inspection Requirements

Inspection requirements shall be as specified in this DEP and on the Drawings.

2.3 EFFECTIVE AREAS

Clarify and add the following:

2.3.2.4 Intermittent Fillet Welds (minimum Length)

Intermittent fillet welds are not permitted as permanent welds but may be permitted for temporary welds.

2.3.3 Skewed T-Joints

CJP skewed T-joint groove and weld dimensions shall be as shown in the Drawings and need not be adjusted for Z-loss.

Part B Specific Requirements for Design of Nontubular Connections (Statically or Cyclically Loaded)

2.6 JOINT CONFIGURATION AND DETAILS

Clarify and add the following:

2.6.5 Butt, Corner, and T-Joint Surface Contouring

Surface contouring and the dimensional limits thereof shall be as specified on the Drawings.

2.6.6 Weld Access Holes

Permanent weld access holes shall not be permitted except as specifically specified on the Drawings. Temporary access holes shall be as specified in Clause 6.

2.7 JOINT CONFIGURATION AND DETAILS – GROOVE WELDS

Clarify and add the following:

2.7.1 Transitions in Thickness and Widths:

The transitions shown in AWS Figure 2.3 shall not be permitted, unless specifically shown in section detail on the Drawings.

2.8 JOINT CONFIGURATION AND DETAILS – FILLET WELDED JOINTS

Clarify and add the following:

2.8.3.2 Lap Joints Subject to Tension

This requirement to terminate tension welds near edges does not apply.

2.8.3.5 Opposite Sides of a Common Plane

Welding on opposite sides of a common plane is permitted.

2.8.5 Intermittent Fillet Welds

Permanent intermittent fillet welds shall not be permitted.

2.10 FILLER PLATES:

Clarify and add the following.

Filler plates shall not be permitted.

2.11 BUILT-UP MEMBERS

Clarify and add the following.

2.11.2 Maximum Spacing of Intermittent Fillet Welds

Permanent intermittent fillet welds shall not be permitted.

Part C Specific Requirements for Design of Nontubular Connections (Cyclically Loaded)**2.16 DETAILING, FABRICATION AND ERECTION**

Clarify and add the following.

2.16.1.1 Butt-Joint Thickness Transitions

Thickness transitions shall generally have a slope of no more than 1 in 4, as shown on the Drawings. The referenced AWS Figure 2.3 shall be modified to AWS Figure 2.2.

2.16.2 Backing

Permanent steel backing shall not be permitted unless specifically specified on the Drawings.

2.16.3 Contouring Weld at Corner and T-Joints

Surface contouring and the dimensional limits thereof shall be as specified on the Drawings.

2.17 PROHIBITED JOINTS AND WELDS

Clarify and add the following.

2.17.1 One-Sided Groove Welds

Revise to:

Non-backgouged groove welds made from one or two sides, with or without backing, shall be prohibited in Zones 1 and 2. Non-backgouged Zone 3 groove welds, as permitted in accordance with the Drawings, shall be qualified in conformance with Clause 4. This includes groove welds made without backing and those made with removable backing, including steel and other materials. Permanent backing shall not be permitted. This general prohibition applies equally to Critical, Special, Primary, and Secondary Steel and corner joints.

2.17.2 Flat Position Groove Welds

As qualified according to this DEP, bevel-groove and J-groove welds shall be permitted.

Part D Specific Requirements for Design of Tubular Connections (Statically or Cyclically Loaded)**2.20 ALLOWABLE STRESSES**

Clarify and add the following.

2.20.6.6 Fatigue Behavior Improvements

Tubular welding details shall be as shown on the Drawings.

2.20.6.6(3): Peening of the welds shall not be permitted as a means to increase the design fatigue life.

2.23 WELD DESIGN

Clarify as follows.

2.23.2.1 Prequalified PJP Groove Weld Details

Partial Joint Penetration (PJP) welds shall not be permitted unless specifically detailed on the Drawings.

2.24 LIMITATIONS OF THE STRENGTH OF WELDED CONNECTIONS

Clarify as follows.

2.24.1.6 Overlapping Connections

Overlapping tubular connections shall not be permitted unless specifically shown on the Drawings.

2.25 THICKNESS TRANSITION

Clarify as follows.

The thickness transition shown in Figure 2.21, "Welded from One Side-(C) Transition by Taper Weld", shall not be permitted.

2.26 MATERIAL LIMITATIONS

Clarify and add the following.

This DEP applies specifically to structural steels conforming to the requirements contained on the Drawings and in other DEPs and/or Specifications explicitly referenced in the Contract. Material requirements are specified on the Drawings and in DEP 37.81.10.34-Gen.

2.26.2.1 CVN Test Requirements

The CVN toughness minimum absorbed energy shall be as specified on the Drawings.

2.26.2.2 LAST Requirements

The CVN toughness test temperature and LAST shall be as specified on the Drawings.

Clarify the Tables and Figures as follows.

Table 2.3 Allowable Stresses (see 2.5.4 and 2.15.1): The required filler metal strength level shall be matching for all types of applied stress and weld types. If Contractor proposes to use an over-matching filler metal to fulfill a specified welding characteristic other than strength (e.g. CVN impact values), a proposal inclusive of all relevant electrode manufacturing data shall be submitted.

Table 2.6 Allowable Stresses in Tubular Connection Welds (see 2.20.3): Partial Joint Penetration (PJP) welds shall not be permitted unless specifically detailed on the Drawings.

Table 2.9 Z Loss Dimensions for Calculating Prequalified PJP T-, Y-, and K-Tubular Connection Minimum Weld Sizes (see 2.23.2.1): Partial Joint Penetration (PJP) welds shall not be permitted unless specifically detailed on the Drawings.

Figure 2.2 Transition of Butt Joints in Parts of Unequal Thickness (Cyclically Loaded Nontubular) (see 2.16.1.1): Thickness transitions shall generally have a slope of no more than 1 in 4, as shown on the Drawings

Figure 2.3 Transition of Thicknesses (Statically Loaded Nontubular) (see 2.6.5 and 2.7.1): The transitions shown in Figure 2.3 shall not be permitted, unless shown in section detail on the Drawings.

Figure 2.6 Termination of Welds Near Edges Subject to Tension (see 2.8.3.2): This requirement to holdback and/or terminate tension welds near edges does not apply.

Figure 2.8 Fillet Welds on Opposite Sides of a Common Plane (see 2.8.3.5): This prohibition against joining the welds together around the corners of the common plane does not apply.

Figure 2.9 Thin Filler Plates in Splice Joint (see 2.10.1): Filler plates shall not be permitted.

Figure 2.10 Thick Filler Plates in Splice Joint (see 2.10.2): Filler plates shall not be permitted.

Figure 2.11 Allowable Stress Range for Cyclically Applied Load (Fatigue) in Nontubular Connections (Graphical Plot of Table 2.5): If the fatigue stresses are of variable amplitude (i.e. if the stress range is not constant), the threshold ranges (i.e. the no slope portions) in the Figure shall be ignored and the slope of the category lines shall be extended down to the 1 ksi stress range abscissa.

Figure 2.13 Allowable Fatigue Stress and Strain Ranges for Stress Categories (see Table 2.7), Redundant Tubular Structures for Atmospheric Service (see 2.20.6.3): If the fatigue stresses are of variable amplitude (i.e. if the stress range is not constant), the threshold ranges (i.e. the no slope portions) in the Figures shall be ignored and the slope of the category lines shall be extended down to the 1 ksi stress range abscissa.

Figure 2.18 Detail of Overlapping Joint (see 2.24.1.6): Overlapping tubular connections shall not be permitted unless specifically shown on the Drawings.

Figure 2.20 Overlapping K-Connections (see 2.24.2.4): Overlapping tubular connections shall not be permitted unless specifically shown on the Drawings.

Figure 2.21 Transition of Thickness of Butt Joints in Parts of Unequal Thickness (Tubular) (see 2.25): The thickness transition shown in Figure 2.21, "Welded from One Side-(C)Transition by Taper Weld", shall not be permitted.

3 PREQUALIFICATION OF WPS

Clarify and add the following.

3.1 SCOPE

Prequalified and previously qualified WPSs shall only be permitted for Tertiary Steel.

A prequalified WPS differs from a previously qualified WPS. Previously qualified WPSs shall be supported by a Procedure Qualification Record(s) (PQR), that was generated based on the welding of a test coupon, including the recording of specific welding parameters and essential variable data; the nondestructive, as well as the destructive testing of that test coupon, with all results documented in a AWS PQR format. Additional requirements shall be as specified in Clause 4.1.1.

3.3 BASE METAL/FILLER METAL COMBINATIONS

The required minimum filler metal strength level shall be matching for all types of applied stress and weld types. If the Contractor intends to use overmatching filler metals, a detailed proposal shall be submitted.

3.11 COMMON REQUIREMENTS OF PJP AND CJP GROOVE WELDS

Partial Joint Penetration (PJP) welds shall not be permitted unless specifically detailed on the Drawings.

3.12 PJP REQUIREMENTS

Partial Joint Penetration (PJP) welds shall not be permitted unless specifically detailed on the Drawings.

3.13 CJP GROOVE WELD REQUIREMENTS

3.13.4 Tubular T-, Y- and K-Connections

Tubular welding details shall be as shown on the Drawings.

3.14 POST WELD HEAT TREATMENT

Post Weld Heat Treatment (PWHT) shall be as specified in this Clause and DEP 37.81.10.34-Gen.

Clarify the Tables and Figures as follows.

Table 3.1 Prequalified Base Metal-Filler Metal Combinations for Matching Strength (see 3.3): AWS D1.1, Table 3.1, footnote b, may be applicable to Group II steels when using the FCAW welding process; special submittal for this specific over-matching condition shall not be required.

The basic AWS electrode specification, by welding process, shall be as specified in this Table.

Table 3.4 Minimum Prequalified PJP Weld Size (E) (see 3.12.2.1): Partial Joint Penetration (PJP) welds shall not be permitted unless specifically detailed on the Drawings.

Table 3.6 Prequalified Joint Dimensions and Groove Angles for CJP Groove Welds in Tubular T-, Y-, and K-Connections Made by SMAW, GMAW-S and FCAW) (see 3.13.4): Tubular welding details shall be as shown on the Drawings.

Figure 3.3 Prequalified PJP Groove Welded Joint Details (see 3.12): Partial Joint Penetration (PJP) welds shall not be permitted unless specifically detailed on the Drawings.

Figure 3.4 Prequalified CJP Groove Welded Joint Details (see 3.13): Joint designation B-L12-S shall be backgouged unless specified otherwise on the Drawings. Backing shall not be left in-place unless specified on the Drawings.

Figure 3.5 Prequalified Joint Details for PJP T-, Y-, and K-Tubular Connections (see 3.12.4): Partial Joint Penetration (PJP) welds shall not be permitted unless specifically detailed on the Drawings.

Figure 3.6 Prequalified Joint Details for CJP T-, Y-, and K-Tubular Connections (see 3.13.4): These details shall be applicable for connections of square and rectangular Hollow Structural Sections (HSS).

Figure 3.7 Definitions and Detailed Selections for Prequalified CJP T-, Y-, and K-Tubular Connections (see 3.13.3 and Table 3.5): Tubular welding details shall be as shown on the Drawings.

Figure 3.8 Prequalified Joint Details for CJP Groove Welds in Tubular T-, Y-, and K-Connections – Standard Flat Profiles for Limited Thickness: Tubular welding details shall be as shown on the Drawings.

Figure 3.9 Prequalified Joint Details for CJP Groove Welds in Tubular T-, Y-, and K-Connections – Profile with Toe Fillet for Intermediate Thickness (see 3.13.4): Tubular welding details shall be as shown on the Drawings.

Figure 3.10 Prequalified Joint Details for CJP Groove Welds in Tubular T-, Y-, and K-Connections – Concave Improved Profile for Heavy Sections or Fatigue (see 3.13.4): Tubular welding details shall be as shown on the Drawings.

4 QUALIFICATION

Clarify as follows.

For Welding Procedure Specification (WPS) qualification, FCAW-SS (Shelf Shielded) and FCAW-G (Gas Shielded) shall be considered separate processes. Conditions under which fabrication welding is to be done shall be limited to those described in an Approved WPS. The WPS shall include reference to the procedure qualification test records (PQRs) for supporting tests and allowable ranges of welding parameters, based on the actual qualification data. For PQRs, the preheat, interpass temperature, voltage, current and travel speed shall be reported for every individual pass.

A WPS written with more than one supporting PQR shall not permit optional processes but shall uniquely specify the process for each pass.

The attachment of architectural insulation pins by means of a welding process is to be considered Stud Welding and shall follow AWS D1.1, Section 7, as modified by this DEP. Stud Welding requires procedure qualification welding and WPS submittal. Pin and base metal material combinations shall be qualified by test.

Part A General Requirements

4.1 GENERAL

Clarify and add the following.

4.1.1 Qualification Responsibility

WPSs and PQRs shall be qualified, submitted and Approved for the current project. WPSs previously Approved for other Principal projects may be Approved for utilization on this project provided all essential variables of this DEP are complied with. The Principal may Accept the use of existing Procedure Qualification Records (PQRs) to establish new WPSs after a review of the existing data. Each procedure shall be evaluated on a case-by-case basis. If the Contractor proposes to use previously Principal Approved WPS and/or PQR, the WPS and PQR shall be submitted.

The Subcontractors may use the Contractor's WPS/PQRs in areas that are under the direct control of the Contractor's Quality System and provided that the Contractor provides technical support. Direct control requires full time, on-site quality representation (i.e. inspectors and supervisors) at the Subcontractor's location. The Subcontractors shall utilize the Contractor's Quality Manual, Quality Plan, Quality Procedures, and Inspection and Test Plans. Subcontractors working outside the direct control of the Contractor's Quality System shall utilize their own Quality System and establish their own WPS/PQRs. Tubular pipe made from Principal Approved materials and dimensionally in accordance with API Spec 2B shall be welded in accordance with this DEP.

4.1.1.2 WPS Qualification to other Standards

The AWS B2.1.XXX-XX Series of Standard Welding Procedure Specifications shall not be permitted, except for Tertiary Steel.

4.1.1.3 CVN Test Requirements

All welding procedures, except those for Tertiary Steel, require Charpy V-Notch (CVN) and/or Crack Tip Opening Displacement (CTOD) testing to the minimum values shown on the Drawings. CVN and CTOD requirements apply equally to all weld types described in AWS D1.1, Paragraph 4.5. CVN testing is required for each plate position qualified.

AWS D1.1, Table 4.6 shall be used in addition to Table 4.5 for all qualified welding procedures that require CVN and/or CTOD testing per the Drawings. Table 4.5, item 28, does not apply for CTOD testing. CTOD testing shall be done on material thickness equal to the maximum material thickness to be welded. Other CTOD essential variable requirements are listed in Appendix A4.8.7. See Clause 4.7.1 for additional modifications to Tables 4.5 and 4.6.

4.1.2 Performance Qualification of Welding Personnel

Welders, welding operators and tack welders shall be qualified and Approved specifically for Work. Refer to Clause 4.18 clarifications.

4.1.2.1 Previous Performance Qualification

Welders, welding operators and tack welders previously qualified to AWS D1.1 do not require re-qualification provided that their previous qualifications were witnessed and verified by a Principal Approved third party inspection agency and have not expired. A copy of the original certification document, bearing the seal and signature of the inspection agency, the employment maintenance record of the welder and evidence of the NDT or Destructive Testing of his/her test coupon shall be submitted.

Welders exhibiting poor practices and workmanship and/or repair rates outside normal industry practice shall lose their qualification and shall be retested when deemed necessary by the Principal.

No welders or tackers are prequalified.

4.1.2.2 Qualification Responsibility

Refer to clarification provided for Clause 4.18.

4.1.3 Period of Effectiveness

The Contractor's welder continuity records, or equivalent documentation providing information regarding when welding was done, and the date and result of the original testing, shall be required to verify welder certification validity. The Contractor's in-house quality record logs combined with employment record validation through the Contractor's Human Resource (HR) department may be regarded by the Principal as sufficient evidence that the welder was engaged in the desired process, after review of the documentation by the Principal.

4.1.3.1 Welders and Welding Operators

For personnel, previously qualified by the Principal, that have allowed their original qualification to expire, the Principal may Approve the existing qualifications after review of the qualification records. For these cases, one verification test may be required and, when required, shall be performed by each welder or welding operator. Welders with previous 6G and 6GR qualifications shall be requalified in these positions. For welders with previous 3G and higher qualifications, other than 6G and 6GR, the welder shall pass a verification test in the highest position qualified. Verification of welders with lesser qualifications shall be tested with applicable 1G, 2G or fillet weld tests. Welding operator qualification shall be verified by producing a satisfactory radiograph of the first production weld. Welding operator qualification for fillets only shall be verified by producing a 1 F or 2F fillet weld test. Welder or welding operator qualification shall be evaluated on a case-by-case basis. For "all position" welder qualifications of CJP production plate welds (i.e. not including 6G and 6GR), combination 3G and 4G welder qualifications are required.

4.1.3.2 Tack Welders

Refer to the clarification provided for Clause 4.1.3.1.

Part B Welding Procedure Specification

4.5 WELD TYPES FOR WPS QUALIFICATION

Clarify as follows:

Partial Joint Penetration (PJP) welds shall not be permitted unless specifically detailed on the Drawings.

4.6 PREPARATION OF WPS

Clarify and add the following:

Welding Procedure Proposals (WPPs), including those for the repair of defects, shall be submitted. WPPs shall have the format of a WPS. The proposed Procedure Qualification Test (PQT) plan shall be submitted and shall be in the format of a Procedure Qualification Record (PQR).

WPSs and PQRs shall be submitted and shall include all data that is shown in AWS D1.1 Annex N and that is required by this Section. They shall include the steel designation, including the name of the Manufacturer and their material designation for Critical Steel, thickness range, joint detail dimensions and tolerances, position(s), type and AWS classification of welding consumables, including brand and place of manufacture, which are essential variables for Critical Steel, size of electrodes, voltage range for each pass, current range for each pass, travel speed range for each pass, heat input range for each pass,

bead width and pass sequence, depth and width of backgouging for Critical steels, preheating and interpass temperature requirements and post weld heat treatments. For WPSs, the voltage, current and travel speed may be combined into layers or groups but shall be segregated into at least three groups, namely 1) root and hot pass, 2) fill passes, and 3) cap passes.

The Contractor shall submit repair procedures that detail repair and inspection steps to be taken for each type of repair that is likely to be encountered, such as the repair of surface imperfections, weld defects and excessive root openings.

Where the Contractor proposes to fillet weld over a weldable primer or other coating, a proposal shall be submitted prior to performing qualification testing. A WPS, using the proposed primer or coating shall be qualified and submitted; refer to Clause 4.8 for testing criteria, methods and acceptance criteria. Welding over galvanized and/or Thermal Sprayed Aluminum (TSA) surfaces shall not be permitted.

4.7 ESSENTIAL VARIABLES

4.7.1 SMAW, SAW, GMAW, GTAW, and FCAW

To clarify Table 4.5 item 31), the welding PQTs shall be performed for all weld types that the Contractor intends to use (e.g. single-V-groove vs. double-V-Groove). The only exception is that single-bevel-groove and double-bevel-groove welds shall qualify single-V-groove and double-V-groove welds, respectively. Table 4.5, item 32), is clarified as follows. Welding Procedure Qualification Tests (PQTs) shall be performed for each of the ten weld types (e.g. 1 – square-groove, 2 – single-V-groove, etc.) shown in AWS D1.1, “Legend for Figures 3.3. and 3.4”. Production joint details on the WPS may vary from that qualified, provided they meet the requirements of Clause 3.13 and are within the “As-Detailed” tolerances of Figure 3.4 for the specific weld type used in the PQT.

The minimum thickness qualified in Table 4.6 Item 2) shall only be applicable for Critical, Special and Primary Steel. Table 4.6 Item 6) shall be revised to read, “A change in travel progression from vertical down to vertical up and vice-versa”. Table 4.5, Item 27) and Appendices A4.7.6 and A4.8.7 remain applicable.

The shielded metal arc welding (SMAW), submerged arc welding (SAW), gas tungsten arc welding (GTAW), and flux cored arc welding (FCAW) processes are Approved. Other proposed processes shall be submitted for consideration.

The FCAW-SS (Self Shielded) process may be used in a WPS, alone, or in combination with other processes; however any welding procedure using a combination of FCAW-SS as one of the weld metals shall be specifically tested for that sequence. Any combination of WPSs using FCAW-SS (e.g. 1G SAW + 4G FCAW-SS) requires testing of that specific combination. Charpy testing shall examine the region of maximum dilution to verify that the minimum required toughness can be obtained. Other weld metals for the Approved processes that are in accordance with D1.1 Table 3.1, or otherwise tested and Approved, may be combined without limitation.

The use of gas metal arc welding (GMAW) may be Approved for specific applications; however, additional restrictions and limitations are applicable as given in Appendix A4.7.1 and Clause 4.7.3.

4.7.2 ESW and EGW

Delete this clause.

4.7.3 Base-Metal Qualification

Replace with the following:

Welding Procedure Qualification Tests (PQTs) shall be performed for each grade of steel, based on minimum yield strength and/or the referenced industry standard (e.g. API Spec 2H vs. ASTM A572), and for each steel from a different manufacturing process (e.g., normalized, Thermal Mechanical Controlled Processing (TMCP) including Thermal Mechanical Rolling (TMR), quenched and tempered (Q & T), quenched and self-tempered

(QST), normalized and tempered, controlled-rolled, as-rolled, rolled shapes with enhanced chemistry, cast, forged, etc.). For Critical, Special, and Primary Steels, the plate, rolled shape, casting, or forging Manufacturer and manufacturing location shall be an essential variable. Procedure qualification test plate material certificates shall be submitted. Additionally, the following shall apply:

- a. Material selected for PQTs shall have a Pcm value within 0.02 points of the highest Pcm plate that will be used in production.
- b. Welding PQTs performed using low sulfur treatment steels (i.e. less than or equal to 0.006 %) shall not qualify for steels without low sulfur treatment except Tertiary Steel.
- c. Welding PQTs shall be performed on all steels with specially enhanced weldability, as reported by the Manufacturer, (e.g. high heat input resistant steels with fine titanium-nitride or titanium-oxide precipitates). These PQTs may be used to support welding procedures only for the specific steel. The proprietary steel name is an essential variable that shall be included on the WPS.
- d. Additional PQTs shall be performed on rolled shapes for application as Primary Steel that have been produced using special chemistry and/or controlled rolling, TMCP, Q & T, and QST in lieu of normalizing.
- e. An example material matrix for Welding Procedure Qualification Tests (PQTs) utilizing single material test plates that incorporates these essential variables for steels to be utilized is presented in Figure 4.7.3-1. The Contractor's proposed material matrix for PQTs shall be submitted.
- f. The Contractor may consider PQTs using two unique steels in combination on a single test specimen (e.g. different grades, different Manufacturers, varying Manufacturer's locations, unique production processes, etc.). By taking Charpy specimens from both HAZs and performing the macro hardness bead-on-plate test on both sides of the joint, WPSs for both base metals may be qualified by one test weld. An example material matrix for Welding Procedure Qualification Tests (PQTs) utilizing dual material test plates, that incorporates these essential variables for steels to be utilized, is presented in Figure 4.7.3-2. The Contractor's proposed material matrix for PQTs shall be submitted.
- g. For joints between two different grades of steel, the PQTs qualified for the lower grade and higher grade steels may be combined to form a single WPS provided the most stringent requirements applicable to each grade are selected (e.g., a Tertiary Steel member may be welded to a Critical member using a WPS qualified for Tertiary Steel, provided the minimum preheat and maximum interpass temperatures from both WPSs are maintained and that the Heat Input (HI) used is greater than the lowest HI from either WPSs).
- h. When welding metals not listed on Drawings to those steels listed (e.g. CuNi to a listed steel or stainless steel to a listed steel), the following requirements shall apply:
 - Use Primary Steel for one side of the test joint and the other side of the test joint shall be the unlisted metal to be qualified. No higher grade need be tested.
 - Select suitable heat inputs and preheats from an existing PQR that has been qualified for the listed steels.
 - Follow the requirements of Sections 4.8, noting that MT examination shall be replaced with PT for non-magnetic materials). Also, where all-weld-metal tensile tests are required, the minimum tensile strength shall meet that of the lower strength metal joined) and macro-section examination shall be required.

4.7.4 Preheat and Interpass Temperature

Replace with the following:

The use of Annex I for determining preheats shall not be permitted. Preheat temperatures shall not be less than those recommended by the steel Manufacturer, welding consumable Manufacturer or as follows:

1. Table 3.2 of AWS D1.1 for prequalified procedures.
2. Preheats used during the actual PQTs.
3. Table 4.7.4-1, of this DEP, for qualified procedures performed without additional Controlled Thermal Severity (CTS) or Y-Groove testing.
4. Table 4.7.4-2, of this DEP, for qualified procedures performed with additional Controlled Thermal Severity (CTS) and/or Y-Groove testing.
 - CTS testing shall be in accordance with new Clause 4.8.8 for welds of low and medium restraint.
 - Y-Groove testing shall be in accordance with new Clause 4.8.9 for welds of high restraint.

Add new Clauses 4.7.4.1 and 4.7.4.2 as follows.

4.7.4.1 Preheat Temperature Restrictions

- a. When different grades or classes of steel are joined, the higher preheat temperature and the lower maximum interpass temperature shall govern.
- b. Due to inherent restraint for weld repairs an increase of 28°C (50°F) in the stated preheat, shall be made to the applicable preheat requirement and shall be used in the Repair WPS. The repair WPS shall utilize basic preheats established during the PQTs, increased as described above, with no preheat reductions based on Y-Groove or CTS Testing. The reduced preheats specified in Table 4.7.4-2 shall not be used for repair WPSs.
- c. For Critical Steel, the maximum interpass temperature shall not be more than 14°C (25°F) above the actual temperature sustained during Crack Tip Opening Displacement (CTOD) prequalification testing of the base metal or be more than 14°C (25°F) above the actual temperature sustained during CTOD qualifications of the weld metal at the locations sampled by CTOD testing, whichever is lower.
- d. For all other steels, the maximum interpass temperature shall not be more than 28°C (50°F) above the actual temperature sustained for the locations sampled for CVN testing, as shown on Figure 4.40, during the procedure qualification testing. Where prequalified WPSs are permitted, the maximum interpass temperature shall be 250°C (480°F)
- e. For the build-up (buttering) of members as allowed in Section 5.4.4, the maximum interpass temperature shall not exceed that given in (c) and (d) above. Before applying the closing root pass, the interpass temperature shall be allowed to cool to within 28°C (50°F) of the minimum preheat.
- f. For offshore welds and welds performed on quayside floating vessels an increase of 28°C (50°F) in the stated preheat, shall be made to the applicable preheat requirement and shall be used in the offshore WPS.

4.7.4.2 Preheat General Conditions

- a. Preheat temperatures shall be established to develop the specified mechanical properties and to prevent cracking in the weld and HAZ. Preheats shall be established to ensure that the particular base metal/consumable/thickness/preheat/heat input combination is not susceptible to delayed cracking at the lowest preheat, highest Pcm, maximum base metal thickness, lowest heat input, and highest weld metal diffusible hydrogen level permitted by the WPS.
- b. Preheat shall be applied to establish and maintain the required temperatures for a distance equal to the thickness of the part to be welded, but not less than 76 mm (3 in) in all directions (including through thickness) from the point of welding, except for the direction of weld travel which shall be preheated for the length to be welded with the particular weld pass.

- c. Preheat temperature shall be measured a minimum of 76 mm (3 in) from the edge of the weld bevel. Temperature indicating crayons shall not be marked on weld bevels, weld beads or surfaces to be welded.
- d. The interpass temperature shall be measured adjacent to the weld groove. The measurements to determine minimum preheat and maximum interpass temperature shall be taken during the time between successive passes, just prior to initiating the arc for the next pass.
- e. Preheat and interpass temperatures shall be specified in the WPS for the full range of thicknesses, steel grades, and heat inputs allowed by the WPS.
- f. Regardless of which minimum preheat is used, surface moisture at the point of welding, whether visually apparent or not, shall be removed using heat before beginning to weld.

Add the following new Clauses 4.7.5 and 4.7.6.

4.7.5 Consumables

Extra low hydrogen consumables shall be used. Extra low hydrogen consumables are defined herein as those that produce deposited weld metal with less than 5 mL/100 g of diffusible hydrogen in accordance with AWS A4.3 for FCAW-G and SMAW; less than 6 mL/100 g for SAW electrode / flux combination and less than 8 mL/100 g for FCAW-SS.

The Contractor shall not use G class electrodes without proposal and approval for PQR testing. If the results of the PQR testing are acceptable, the specific G Class electrode may be approved for use on the project, with the same chemical composition range, mechanical property testing conditions, acceptance limits manufacturing location and testing frequency requirements as essential variables. When G Class consumables are proposed by the Contractor, chemical composition, mechanical property tests, acceptance limits manufacturing location, and test frequencies shall be submitted.

4.7.6 Additional Essential Variables

Welding procedures shall be qualified by tests within the limitation of variables of AWS D1.1 and as modified herein. These clarifications or modifications shall apply to the welding of Critical Steel, Special Steel, Primary Steel and Secondary Steel and shall be essential variables. Changes outside those permitted herein shall require re-qualification of the welding procedure.

- a. Any change in electrode diameter for welding procedures qualified by CTOD testing, except that tandem (two) wire SAW shall qualify for single wire provided that the pass size of the single wire does not exceed the pass size of the tandem wire (i.e. thickness and width of pass) and that the Heat input (HI) for the single wire does not exceed 1/2 of the HI as computed for the tandem wire SAW WPSs.
- b. Any change in electrode or electrode/flux, AWS classification, brand name, or electrode Manufacturer. For Critical Steels, those requiring (CTOD) tested procedures, the place of manufacture shall be an essential variable.
- c. Any change in the mode of metal transfer across the arc.
- d. Any change in the type of welding current or polarity. For single process WPSs, the polarity used for successive passes shall never change (i.e. if reverse polarity is used on the root pass of a weld, the weld shall be completed using reverse polarity).
- e. Any change in HI outside the established range. For detailed information on setting HI ranges, see Appendix A4.7.6.
- f. For welding procedures qualified using flat plate test pieces in the PQT, the forming strain of tubular production pieces shall be limited to 3 % or less (or a D/t ratio of 35 or more), and as further restricted by AWS D1.1, Table 4.1 (where D is the outside diameter and t is the thickness of the production tubular). For example, per

Table 4.1, flat plate test pieces do not qualify T-, Y-, K- connections and there are also restrictions on diameter.

- g. For welding procedures qualified using tubular test pieces in the PQT, with forming strains of 3 % or less (or a D/t ratio of 35 or more), and having heat input equal to or less than 3.15 kJ/mm (80 kJ/in) the forming strain of the tubular production pieces shall be limited to 3 % or less (or a D/t ratio of 35 or more), and as further restricted by AWS D1.1, Table 4.1 (where D is the outside diameter and t is the thickness of the production tubular).
- h. For welding procedures qualified using tubular test pieces in the PQT, with a forming strain of 3 % or less (or a D/t ratio of 35 or more), and having heat input greater than 3.15 kJ/mm (80 kJ/in), the maximum forming strain of the tubular production pieces shall be limited to the forming strain of the tubular used for the PQT, and as further restricted by AWS D1.1, Table 4.1 (where D is the outside diameter and t is the thickness of the production tubular).
- i. For welding procedures qualified using tubular test pieces in the PQT, with a forming strain more than 3 % (or D/t ratio less than 35) and with heat input below or above 3.15 kJ/mm (80 kJ/in), the maximum forming strain of the tubular production pieces shall be limited to the forming strain of the tubular used for the PQT, and as further restricted by AWS D1.1, Table 4.1 (where D is the outside diameter and t is the thickness of the production tubular).
- j. For CTOD tested procedures, a reduction of the depth or width of backgouging. The maximum depth and width of backgouging recorded during the PQT shall be the minimum backgouge depth and width specified on the WPS.

4.8 METHODS OF TESTING AND ACCEPTANCE CRITERIA FOR WPS QUALIFICATION

Clarify and add the following:

Procedure qualification welding, non-destructive examination (NDT), sectioning, machining and mechanical properties testing shall be witnessed by the Principal unless waived on a case-by-case basis.

Welding procedures shall be qualified by non-destructive examination and mechanical tests as specified in AWS D1.1 and as modified by this section. This includes all longitudinal and girth welds for tubulars made from rolled plate using API Spec 2B.

- a. Mechanical testing shall be performed by an Approved testing laboratory. The proposed test laboratory and latest audit report shall be submitted. Ultrasonic and radiographic examinations shall be performed by Approved technicians. The UT reports and/or graded radiographs shall be submitted.
- b. The results of testing, an original photo-macrograph clearly showing the locations of the hardness testing and copies of the mill certificates shall be included with the PQR and submitted with the WPS. The PQR shall also include the steel Manufacturers' API RP 2Z prequalification record for CTOD WPSs, and the electrode Manufacturers' recommendations regarding heat input, minimum preheat and maximum interpass temperature.
- c. For newly-qualified PQRs, the Contractor shall retain and preserve all mechanical test specimens and macro-sections until the completion of the Work or until a written release is given by the Principal.
- d. Where the Contractor proposes to fillet weld over a weldable primer or other coating, a proposal shall be submitted prior to performing qualification testing. A procedure shall be qualified using the proposed primer or other coating that will be used in production. If both members to be joined will be coated in production, both of the test plates shall be coated accordingly. Proof of a non-toxic fume shall be furnished with the PQR. Testing and procedure qualification shall be in accordance with AWS D1.1, including acceptance of the macro-etch specimens and an additional fillet weld break

test in accordance with AWS D1.1 Clauses 4.30.2 and 4.30.4. The two plates of the fillet weld break test shall be brought into as close contact as practicable for the test.

- e. The maximum thickness of the coating shall be an essential variable. The minimum thickness measured on the test plate shall be the maximum thickness permitted during production. The Contractor should qualify a weldable primer with a production coating thickness less than 20 microns and a zinc content less than 68 %.
- f. The Principal may reject the use of weldable primers based upon compatibility with coating systems, quality control issues, or other concerns.
- g. For Complete Joint Penetration (CJP) welds, welding over primers shall not be permitted.
- h. For flat plate, test plate assemblies shall be prepared so that the Principle Rolling Direction (PRD) of the plate is oriented parallel to the weld axis in order that CVNs from the HAZ will test the transverse properties of the altered base metal. For shapes and manufactured pipe, test plate assemblies shall be oriented to test base metal in the longitudinal direction.

All results of mechanical testing (including results of failed tests) shall be submitted to the Principal in the form of a PQR or test dossier.

4.8.1.1 Visual Inspection of Groove Welds

Test welds shall be visually examined over 100% of the length of weld surfaces. 25 mm (1 in) at the beginning and end of each plate test piece may be disregarded. Visual acceptance by the Contractor and Principal shall be required prior to mechanical testing. The weld shall meet the AWS D1.1 requirements for weld profiles and visual examination as specified in Clauses 5 and 6.

4.8.1.2 Visual Inspection of Fillet Welds

Test welds shall be visually examined over 100% of the length of weld surfaces. 25 mm (1 in) at the beginning and end of each plate test piece may be disregarded. Visual acceptance by the Contractor and Principal shall be required prior to mechanical testing. The weld shall meet the AWS D1.1 requirements for weld profiles and visual examination as specified in Clauses 5 and 6.

4.8.2.1 RT or UT

Test welds shall be examined 100% by the NDT methods given below. 25 mm (1 in) at the beginning and end of each plate test piece may be disregarded. NDT shall be performed and the results shall be submitted prior to cutting specimens for mechanical testing. Ultrasonic examinations shall use API RP 2X Level "A" acceptance criteria.

- Butt welds shall be examined by radiographic examination (RT) or ultrasonic examination (UT).
- Tee-joint welds and tubular intersection welds (T-, Y-, K- connections) shall be examined and accepted by ultrasonic examination (UT).
- Fillet welds shall be examined by magnetic particle examination (MT).

4.8.3.6 All-Weld-Metal Tension Specimen

Yield and tensile strength, as measured by the AWS All Weld Metal Tensile Test, shall be provided for each type, size and combination of consumables shown in the proposed weld procedure.

The yield and ultimate strength obtained from the All Weld Metal Tensile Test shall meet the minimum properties required of the filler metal and the ultimate strength shall be greater than or equal to the tensile strength of the base material.

4.8.4 Macroetch Test

Clarify as follows: