

GAP ANALYSIS FOR NORSOK M-101 & AWS D1.1

Report No:001

Date:10/10/11

Sr No.	Details	NORSOK M-101	AWS D1.1	
			Requirements for Qualification	Requirements for Prequalification
1	1.1 SCOPE :	This standard covers the requirements for fabrication and inspection of offshore steel structures with SMYS ≤ 500 MPa and with a minimum design temperature down to -14°C. For special application steels with SMYS up to 690 MPa may be used.	This code contains the requirements for fabricating and erecting welded steel structures	
2	2.1 Reference Standard	Reference of AWS D1.1 is not taken in normative references.	No reference of NORSOK	
3	3.1 Design Classes	Reference is NORSOK standard N-004(for the purpose of steel quality level -SQL - Annex B)	Covers design of welded connections composed of tubular, nontubular, product form members	
	3.2		Common Requirements for Design of Welded Connections(Nontubular & Tubular Members)	
4	4.1 Prequalification	Not covered	Covers the requirements for exempting a WPS from qualification requirements of this code.	The prequalified Base Metal - Filler Metal combination is provided in Table 3.1
5	5.1 Qualification	In accordance with EN 288 part 2	This section contains the qualification requirements for WPSs and welding personnel (welders, welding operators and tack welders) necessary to perform code work.	
	5.2	As per the Steel Quality Level the qualification shall be in accordance with EN 288 part3.	The prequalified Minimum Preheat & Interpass Temperature is provided as per base metal thickness in Table 3.2	
6	Limitations	As described in the Scope for Norsok M-101	The limitations applied for usage of the following parameter :	
	6.1		Steels with minimum specific yield strength greater than 100ksi(690 Mpa) not intended to be used	
	6.2		Steels less than 1/8 in.(3mm) not intended to be used	
	6.3		Pressure vessels or pressure piping	
	6.4		Base metal other than carbon or low-alloy steels.	
7	7.1 Responsibility	The qualification is primarily valid for the workshop performing the welding tests, and other workshops under the same technical and quality management. It may also be transferred to and used by a subcontractor, provided the principles of EN 729 part 2 are implemented and documented	The Engineer shall be responsible for the development of the contract documents that govern products or structural assemblies produced under this code. The Engineer may add to, delete from, or otherwise modify, the requirements of this code to meet the particular requirements of a specific structure.	
8	8.1 WPS Qualification to other Standard	WPS shall be established in accordance with EN 288 part 2.	The acceptability of qualification to other standards is the Engineer's responsibility, to be exercised based upon the specific structure or service conditions, or both	
	8.2	WPS shall be qualified in accordance with EN 288 part 3 and the additional requirements in this standard		
For welding of steels with SMYS ≤500 Mpa the following range of approval applied as per NORSOK M-101				
9	9.1 Welding Process	Welding process(es) used shall be designated in accordance with EN 24063.	SMAW,SAW,GMAW,GTAW & FCAW : Changes beyond the limitations of PQR essential variables shown in Table 4.5 & Table 4.6	
	9.2		ESW & EGW : Table 4.7 for the PQR essential variable changes requiring WPS requalification	
10	10.1 Base Metal	A change from wrought (rolled, forged) steel to cast steel or converse.	Any steel to itself or any steel to another in the same group (Table 3.1)	
	10.2	When the steel to be welded has a Pcm ≥ 0.21, or a carbon content C ≥ 0.13%, then an increase of more than 0.02 Pcm units or 0.03 carbon equivalent units (IIW formula) over the value on the approval test shall require a new qualification test.	Any steel in one group to any steel in another (Table 3.1)	
	10.3	A change in delivery condition (normalized, thermo mechanically controlled processed or quenched and tempered).	Any steel to any steel in any group (Table 3.1)	
	10.4	A change in micro alloying element or manufacturing technique for steel with SMYS ≥ 400 MPa.	As per Table 4.2, Essential Variables for Base Metal(For: Thickness of base metal & Diameter qualified)	
	10.5	En288 - 3 ; Table 5. Range of approval for thickness and Table 6 for Range of approval for pipe and Brach connections.	As per Table 4.6, Supplementary Essential Variables for Base Metal(For: Group Number & Thickness of base metal)	
11	11.1 Joint Design/Joint Type	The range of approval for types of welded joints is described in En 288-3, Table 7.	CJP Groove Joint : As per 3.13	
	11.2	Sketch the Joint design showing configuration and dimensions	PJP Groove Joint : As per 3.12	
	11.3	Weld run sequence shall be given on the sketch if essential for the properties of the weld	Fillet Joint : As per 3.9, (Table 5.8 for minimum fillet weld sizes.)	
	11.4	A change in groove angle more than +20 deg./-10 deg.	for Tubular Root Opening ±5 Deg.	
12	12.1 Fillet welds	A qualification of fillet welds carried out on plate thickness equal to or greater than 30 mm, applies for all plate and throat thicknesses. Single layer fillet welds qualifies multi-layer, but not the converse		
13	13.1 Welding Consumables	Welding consumables applied for joints where steel quality level I, II and III are required, meet the requirements for mechanical properties as specified for the welding procedure qualification, in both as welded and (where applicable) PWHT condition	WPS requalification for various essential variables due to Welding Consumable as listed in Table 4.5	
	13.2	The welding consumable designation, manufacturer and trade name must be noted in the WPS		
	13.3	Diameter of electrode/wire or width and thickness of strip electrode.		

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14	14.1	Filler Metal If a filler metal or flux is to be dried or treated before use, this shall be specified. Reference to an appropriate standard is permitted.	As per Table 4.5 for PQR Essential Variable.	
	14.2		As per Table 4.6 for PQR Supplementary Essential Variable (CVN Testing)	
	14.3		The filler metal strength may decreased without WPS Requalification.(for SAW, FCAW & GTAW Process only as per Table 4.5)	
15	15.1	Electrode Diameter of electrode/wire or width and thickness of strip electrode.	Change in nominal electrode diameter by 0.8mm increase (For SMAW), Any increase (For SAW & FCAW), Any increase or decrease (For GMAW) and 1.6mm increase or decrease (For GTAW) - As per Tabel 4.5	
16	16.1	Position Qualified Reference EN288 part2 - EN ISO 6947	As per Table 4.1, the Position Qualified for Plate & Tubular and Table 4.5 for essential variable and Table 4.6 for supplementary Essential Variables (CVN Testing)	
	16.2	EN288 - 3 ; Section 8.4.2 for requirement related with impact & hardness.	A change in position not qualified by Table 4.1	
17	17.1	Preheat & Interpass Temperature The minimum interpass temperature shall not drop below the minimum required preheat temperature. If not otherwise stated in the WPS, and qualified by the WPAR, the maximum interpass temperature shall not exceed 250°C measured at the edge of the groove. For C- and C/Mn steels, a maximum interpass temperature of 250°C may be used, even if a lower temperature was recorded on the WPAR.	To be established on the basis of still composition as per Table 3.2. Alternately Preheat & Interpass can be determined as per guidelines from Annex XI.	
	17.2		Decrease from preheat temperature by :15 deg C and 55 deg C.for GTAW(Table 4.5)	
	17.3		Increase in Interpass temperature for 56 deg C When CVN Testing requires.(Table 4.6)	
	17.4		Decrease from interpass temperature by :15 deg C and 55 deg C.for GTAW(Table 4.5)	
18	18.1	PWHT Stress relieving if required/specified by designer	Addition or deletion of PWHT as per Table 4.5	
	18.2		A change in the PWHT temperature and/or time ranges. The PQR test shall be subject to 80% of the aggregate times at temperature(s). The PWHT total time(s) at temperature(s) may be applied in one heating cycle(Table 4.6) for supplementary essential variables	
	18.3		The specified minimum yield strength of the base metal shall not exceed 50 ksi [345 MPa]	
	18.4		The base metal shall not be manufactured by quenching and tempering (Q&T), quenching and self tempering (Q&ST), thermo-mechanical controlled processing (TMCP) or where cold working is used to achieve higher mechanical properties (e.g., certain grades of ASTM A 500 tubing).	
	18.5		There shall be no requirements for notch toughness testing of the base metal, HAZ, or weld metal There shall be data available demonstrating that the weld metal shall have adequate strength and ductility in the PWHT condition (e.g., as can be found in the relevant AWS A5.X filler metal specification and classification or from the filler metal manufacturer). PWHT shall be carried out as per requirements stated in 5.8 of Section 5.	
19		Technique As per En288-3, Section 4.4.5		
	19.1	Stringer or weave bead Specify whether Stringer or Weaving	As per Table 4.6 - In the 3G position, a change from stringer to weave	
	19.2	Multi/Single pass	As per Table 4.6 -A change from multipass per side to single pass per side	
	19.3	Number of Electrode FOR SAW Welding Process - For multiple electrode systems the number and configuration of wire electrodes and electrical connections	As per Table 4.6 -A change from single electrode to multiple electrodes in the same weld pool and vice versa. Also as per Table 4.5 - change in number of electrode	
19.4	Oscillation For mechanized welding dwell time of oscillation.	As per Table 4.6 -A change exceeding ±20% in the oscillation variables for mechanized or automatic welding		
20	20.1	Electrical Parameters		
	20.2	Amperage Current range must be noted	A change in the amperage for each diameter used as per Table 4.5 for various process	
	20.3	Type of current (AC or DC) or Polarity Type of current (Ac or DC) and polarity must be described	As per Table 4.5	
	20.4	Voltage Voltage range must be noted	As per Table 4.5	
	20.5	Wire Feed Speed Wire feed range has to be specified	As per Table 4.5 - An increase or decrease (>10%) for each electrode diameter for SAW GMAW & FCAW Process	
	20.6	Travel Speed Travel speed range has to be specified	As per Table 4.5	
	20.7	Heat Input If an approval testing have been performed at both high and low heat inputs level(with all specified mechanical testing) then all intermediate heat inputs are also qualified. As per En 288-3 : The clause 8.4.7 will only be applicable if the control of heat input is specified. - (When Impact requirements apply - 25% greater (upper limit of heat input) than that used in welding the test piece & -When Hardness requirements apply - 25% greater (lower limit of heat input) than that used in welding the test piece)	As per Table 4.5 - An increase of (>10%) for SMAW,SAW GMAW & FCAW Process and Any(when CVN tests required) for GTAW Process.	
	20.8		>10% (Increase) in SMAW, SAW, GMAW, FCAW and any in GTAW(when CVN tests are required)	

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21	21.1 Shielding Gas	NORSOK M -101, Annex C: Qualification of Welding Consumable	As per Table 4.5	
22	22.1 Type of Qualification Test	Type and number of test : Table 5.1 for Mechanical Testing	The type and number of qualification tests required to qualify a WPS for a given thickness, Diameter or both shall conform to Table 4.2,4.3 & 4.4 .	
	22.2 Method of Testing and Acceptance Criteria for WPS Qualification (Mechanical Test : No. of Samples as per Joint Configuration & Thickness)	The test weld shall be 100% examined for both surface and volumetric defects with the relevant NDT-methods. The soundness of the weld shall comply with various requirement of NDT.	As per 4.8 : The test assemblies must conform following inspection	
	22.3	Visual Inspection : NORSOK M-101, Section-9.3. Table 9.1	4.8.1 : Visual Inspection - The welds shall meet the various requirements mentioned.	
	22.4	NDT : shall be carried out as per NORSOK M-101, Section-9. Table 9.1 & 9.3 (for acceptance criteria.)	4.8.2 : NDT - Before preparing mechanical test specimens, qualification test plate, pipe, or tubing shall be nondestructively tested for soundness as follows:	
	22.5	NDT shall be carried out as per NORSOK M-101, Section-9. Table 9.1 & 9.4(for acceptance criteria.)	4.8.2.1 : RT or UT - The welds shall be examined in conformance with Section 6(Part C,E or F - as applicable)	
	22.6	NDT shall be carried out as per NORSOK M-101, Section-9. Table 9.1	4.8.2.2 : RT or UT Acceptance Criteria - The welds shall conform to the requirement of Section 6(Part C)	
	22.7	In addition to Norsok M-101, the extent of examination and testing shall be as per EN 288-3,Section 7 for Examination & testing	4.8.3 : Mechanical Testing	
	22.8		4.8.3.1 : Root, Face and Side Bend Specimens.	
	22.9		4.8.3.2 : Longitudinal Bend Specimens.	
	22.10		4.8.3.3 : Acceptance criteria for Bend Tests.	
	22.11		4.8.3.4 : Reduced-Section Tension Specimens	
	22.12		4.8.3.5 : Acceptance criteria for Reduced-Section Tension Test	
	22.13		4.8.3.6 : All-weld-metal Tension Specimen	
	22.14		4.8.4 : Macroetch Test.	
22.15		4.8.4.1: Acceptance Criteria for Macroetch Test.		
22.16		4.8.5 : Retest - If any one specimen of all those tested fails to meet the test requirements, two retests for that particular type of test specimen may be performed with specimens cut from the same WPS qualification material. The results of both test specimens shall meet the test requirements. For material over 1-1/2 in. [38 mm] thick, failure of a specimen shall require testing of all specimens of the same type from two additional locations in the test material		
23	23.1 CVN Test Requirements	Charpy V-notch testing shall be as per 5.4.2 and the test temperatures and energy requirements shall be as per Table 5.2	When required by contract drawings or specification. The test, requirements and procedure shall be in conformance with provisions of Annex III.	
24	24.1 CTOD Testing	CTOD testing shall be included in the qualification of welding procedures for weldments with a plate thickness above 50 mm for all strength levels for steel quality level I and II and for SMYS >400 MPa for steel quality level III. CTOD testing shall be included in the qualification of welding procedures for weldments with a plate thickness below and equal 50 mm if requested by the designer for the specified steel quality level.(Shall be carried out as per 5.4.4)	CTOD qualification testing is presently being applied as a supplementary requirement for high-performance steels such as API Specs 2W and 2Y, and is accepted as a requirement by some producers.	
25	25.1	For welding of steels with SMYS>500 Mpa : In addition to the above requirements the following additional requirements apply :		
	25.2	CTOD	CTOD testing as described in 5.3.1 h) shall be executed for thicknesses above 30 mm	
	25.3	Steel Manufacturer	A change in steel manufacturer.	
	25.4	Carbon Equivalent	When the steel to be welded has a Pcm ≥ 0,21 or a carbon content ≥ 0,13, then an increase of more than 0,03 Pcm or 0,04 carbon equivalent units (IIW formula) over the value of the approval test shall require a new qualification test.	
26	26.1 Welder & welding operators qualifications	Shall be qualified as per EN287, EN1418	Shall be qualified as per Table 4.9.	