

Guidance Note : Material Data Sheet for Super Duplex Tubes

UMF – GN03

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Introduction

This document is intended to provide general guidance information on the technical properties, test requirements, and process control parameters for super duplex steel tubes to be utilised in subsea umbilicals.

The information is intended to be of benefit to:-

- Steel tube manufacturers
- Subsea umbilical specifiers
- Subsea umbilical designers
- Subsea umbilical manufacturers
- Subsea umbilical installers
- Subsea umbilical end users and specifiers

MATERIAL DATA SHEET

MDS

TYPE OF MATERIAL:	ASTM A789/789M Ferritic/Austenitic Stainless Steel, Type 25Cr duplex	
PRODUCT:	Seamless tubes for umbilical	
GRADE:	UNS S32750 UNS S32760 UNS S39274	
APPLICABLE STANDARDS (latest revision at the time of order placement if not stated otherwise):	ASTM: , A789, A1016, A370, E562, E426, E213, E309, G48, G46, A923	EN 10204 ISO 13628-5 (2009)
SCOPE	Seamless Super Duplex Stainless Steel Tubes for Umbilicals	
TECHNICAL REQUIREMENTS		
Chemical composition	Chemical composition according to the relevant UNS codes.	
Pitting Resistance Equivalent	$PRE = [\%Cr] + 3.3x([\%Mo] + 0.5x[\%W]) + 16x[\%N] \geq 41,5$	
Mechanical	Yield Strength (Rp 0.2):	Min 550 MPa
	Tensile Strength (Rm):	Min 800 MPa
	Yield/tensile strength ratio:	Max 0.90
	Elongation (A2,)	Min. 25%
	Hardness	Max. 32 HRC /315 HV 10 (HV 5)
	Impact	Min. 50 J at -46°C
Compatibility	The material compatibility shall be in accordance with ISO 13628-5.	
Microstructure	The ferrite content shall be within 35-55%. The material shall be essentially free from grain boundary carbides, nitrides and inter metallic phases.	
Surface condition	The tube surface shall be without defects or irregularities exceeding specified reference notch for NDE.	
Tube dimensions	<p>Tube length, outer diameter and wall thickness is defined in the purchase order.</p> <p>Outer diameter, wall thickness minimum tolerance and ovality shall be within the limits given in ASTM A789 table 5 and straightness according to ASTM A1016, unless otherwise stated in the purchase order.</p>	
SAMPLE TESTING		
The testing shall be performed at ambient temperature unless otherwise stated below. The test frequency is given per lot. The lot sizes shall be as defined in ASTM A789 for different tube sizes.		
Chemical composition	<p>At the steel melting stage, an analysis shall be performed per heat to verify that the chemical composition is according to UNS requirements and that min PRE is achieved.</p> <p>Trace elements such as O, Sn, As, Sb and B, shall be measured and reported per heat. Maximum acceptable content of each element shall be in accordance with tubing manufacturers written specification.</p>	

Tension testing	Tension testing shall be performed according to ASTM A370. Number of specimens to be tested shall be in accordance with ASTM A789.
Hardness testing	Hardness testing shall be performed according to ASTM A370. Number of specimens to be tested shall be in accordance with ASTM A789.
Impact testing	<p>When Charpy V-notch testing is required, it shall be carried out according to ASTM A 370 with the following requirements:</p> <ul style="list-style-type: none"> - Test temperature: minus 46°C - No. of test samples: 3 per lot - Min. average absorbed energy: 50J - Min. single value: 40J <p>Reduction factors for sub-size specimens shall be: 5/6 for 7,5 mm, 2/3 for 5 mm and 1/3 for 2,5 mm. The other outer edges of the specimen shall be 10 and 55 mm. Impact test is only required for tube sizes from which 10x2,5 mm test specimen can be taken.</p>
Flattening test	Flattening test shall be performed according to ASTM A1016 on one tube per lot. e = 0.09
Flaring test	Flaring test shall be performed according to ASTM A1016. Number of tube specimen and minimum expansion according to ASTM A789.
Burst test	Burst testing of tubes shall be performed according to ISO 13628-5.
Corrosion	<p>One pitting corrosion test according to ASTM G 48 method A is required per lot. Test temperature shall be 50°C and the exposure time shall be 24 hours. The test specimen surface shall be in the as-delivered condition prior to testing. The test shall expose the external, internal and cross section surface in full wall thickness. No visible pitting corrosion attack is acceptable at 20X magnification. Probing with a sharp instrument is required. The weight loss shall be less than 1.0 g/m².</p> <p>Should a pitting corrosion test fail, then a propagation test may be performed in strict accordance with tubing manufacturer's written specification.</p> <p>ASTM G48 method B is not relevant for tubes. Any crevice corrosion testing should be in accordance with manufacturer's written specification.</p>
Microstructure	<p>One micrographic examination is required per lot and shall cover the surfaces and mid-thickness region. The ferrite content shall be determined and presented according to ASTM E562. The content shall be within 35-55%.</p> <p>The microstructure, as examined at minimum 400X magnification on a etched specimen shall be essentially free from grain boundary carbides, nitrides, precipitates and inter metallic phases. The total amount of these phases shall not exceed 0.05%. The count method shall be in accordance with the tubing manufacturer's written specification.</p>

NON DESTRUCTIVE EXAMINATION (NDE)	
<p>Eddy current and ultrasonic examination methods shall be performed on all tubes, excluding the cut-off ends, in order to detect crack like defects and other irregularities. The calibration and examination shall be performed in accordance with ASTM A1016 and with the following:</p> <p>After NDE, the non-examined ends of each tube shall be cut off. The length of the non-examined ends shall be verified by testing during the calibration check to be within the length that is to be cut off.</p> <p>Every tube shall have one accepted record from NDE. Therefore, all tubes that have a record showing unacceptable indications shall either be rejected or cut out. After cutting the tube shall be subjected to a complete re-examination in the NDE equipment.</p>	
Cleanliness	The inside cleanliness of the tubes shall be verified by foam plugs or other agreed method at the tube works prior to delivery.
Dimensional check (OD and WT)	The whole length of all the tubes shall be examined to detect dimensional deviations (WT and OD). The WT shall be measured by ultrasonic examination in a helix along the tube. The OD shall be measured by laser in at least two perpendicular levels or by ultrasonic examination in a helix along the tube.
Straightness	The tubes shall be of a sufficient straightness to permit rolling the tube by hand on a flat surface.
Tube end square ness	The tube ends shall be square cut and free from burrs.
Eddy current examination	Calibration shall be performed in accordance with ASTM A1016. Each tube shall be 100% examined in accordance with ASTM E426.
In-line sigma phase detection	<p>Sigma phase detection shall be performed during Eddy Current examination and shall examine each tube along its complete length.</p> <p>A calibration reference containing a max of 2% sigma phase shall be used to demonstrate the capability of detecting sigma phase. The maximum amount of sigma phase detected in the tubes shall not exceed 2%.</p> <p>The control reference shall have the same nominal physical dimensions as the tubes under test. This control reference shall have a sigma phase level less than 0.05%.</p>
Ultrasonic examination	<p>Calibration shall be performed in accordance with ASTM A1016 and each tube shall be 100% examined circumferentially and axially according to ASTM E213.</p> <p>Notches shall include both inside and outside of the tube.</p> <p>The reference standard for calibration shall have at least 4 artificial U or V or square shaped defects (notches). There shall be a longitudinal and a transversal notch at both internal and external tube surface.</p>
Marking	All tubes shall be marked every 1 m.
Visual inspection	<p>Surface discontinuities may be removed by grinding. The remaining tube dimensions shall nevertheless be within the limits given in ASTM A789. Any depression formed during grinding shall be blended smoothly into the adjacent area.</p> <p>Any repaired area shall be subjected to the following testing: Ultrasonic wall thickness measurement. Outer diameter measurement. All tubes shall be checked for correct marking.</p>
Positive material	Positive material identification (PMI) shall be performed on each tube. The

identification (PMI)	method must be capable of differentiate between Super Duplex material and other materials, and shall be proven not to be detrimental to the material.
	PROCESS CONTROL
General	The tube manufacturer is required to establish specifications for controlling each process during tube manufacturing.
Pre heat treatment cleanliness	The tubes shall be cleaned inside and outside prior to heat treatment. Internal cleanliness shall be verified 100% by foam plugs and a white cloth. Acceptance criteria for both external and internal cleanliness shall be in accordance with tube manufacturers' written procedure.
Heat treatment	<p>Heat treatment is regarded as a critical process for ensuring tube quality because of its sensitivity and as such strong emphasis has to be built into the process control.</p> <p>A verification check of the heat treatment process shall be performed by the use of a thermocouple inside a tube. If the recorded annealing temperatures or cooling time are outside manufacturers written specification, the tubes heat treated after the last accepted verification shall subject to a non-conformance report. The frequency of such verification shall be in accordance with the manufacturers' written specifications.</p> <p>The process shall be qualified within the tolerances set for the important process parameters. These parameters are typically annealing and cooling zone temperatures or inlet and outlet temperatures in the cooling medium, speed of the tubes throughout the heat treatment process and number of tubes in the process. These parameters shall be measured and recorded continuously during the entire process.</p> <p>Repeating the heat treatment process is acceptable as long as the re-heat treated tubes are considered as a separate lot. Limitation on the number of times annealing can be carried out should be limited to a further Two (2) times.</p>
Delivery	The tubes shall be packed in such a way that the material will be received in an undamaged condition and according to this specification. The packing method shall be suitable for long term outdoor storage and in accordance with the manufacturers' written specification.
Certification	A Material Test Certificate shall accompany each delivery to minimum requirements as specified in EN 10204/3.1 stating the quantity, type of material and all test results according to this specification.