

TECHNICAL SPECIFICATION

DUPLEX AND SUPERDUPLEX STAINLESS STEEL PIPE (AMENDMENTS/SUPPLEMENTS TO ASTM A 790)

MESC SPE 74/014

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(Including Technical Errata To September 2012 Revision)

MESC SPECIFICATION DOCUMENT



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PART I INTRODUCTION

1.1 SCOPE

This MESC SPE specifies requirements for duplex and superduplex stainless steel pipe.

This specification shall apply in addition to the applicable MESC Buying Description, purchase order or requisition sheet.

This specification only applies to duplex stainless steel pipe and to superduplex stainless steel pipe to ASTM A 790

This specification is written as amendments and supplements to ASTM A 790 / **A790M-11 (2011)**, which are covered in Part II of this MESC SPE. The clause numbering of ASTM A 790 / **A 790M-11(2011)** has been retained and any amendments are identified as 'Add', 'Modify to read' or 'Delete'. Any clauses of ASTM A 790 / **A 790-11(2011)** that are not amended or supplemented by this MESC SPE, shall apply as written.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this MESC SPE is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them.

This MESC SPE is intended for use in oil refineries, chemical plants, gas plants, exploration and production facilities and, where applicable, supply/distribution installations.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this MESC SPE 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 safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this MESC SPE 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 MESC SPE as closely as possible.

1.3 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 or maintenance of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Inspector** is the party appointed by the Principal to check that the products supplied comply with this MESC SPE.

The **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 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.

1.4 CHANGES SINCE PREVIOUS EDITION

The previous edition of this MESC SPE was dated **May 2010**. The main changes are:

- **update email address of MESC SPE administrator**
- **Updated chemical composition requirements;**

- Updated impact testing requirements;
- Incorporate thickness limitation for welded pipes without filler material
- Incorporated requirement - “Length” for pipes
- Errata – 1 (December 2012): USC unit rounded off
- Errata – 2 (December 2012): Exposure time added.
- Errata – 3 (December 2012): USC unit added.

1.5 COMMENTS ON THIS MESC SPE

Comments on this MESC SPE may be sent to the MESC SPE Administrator at MESC@shell.com. Shell staff may also post comments on this MESC SPE on the Surface Global Network (SGN) under the Standards folder.

PART II AMENDMENTS/SUPPLEMENTS TO ASTM A 790:11

- 6.1.1 *Add:* Only high frequency welding (HFW) and laser beam welding (LBW) are acceptable automatic welding processes.
- 6.3** *Modify to read:*
All pipe shall be furnished in the solution annealed condition as per in Table 1 and shall be quenched by rapid cooling in water.
- 6.3.2 *Delete*
- 6.3.2.1 *Delete*
- 6.3.2.2 *Delete*
- 6.4** *Add* **Pipe with a wall thickness > 6.4 mm (0.25 in) shall be furnished seamless, unless otherwise approved by the Principal.**
- 7** *Add* **In addition, the requirements under section 9.2 apply.**
- 9.1 *Delete from the 1st sentence:*
At the request of the purchaser's inspector,
- 9.2 *Add* For "22Cr" duplex (ferritic/austenitic) stainless steels, the Pitting Resistance Equivalent (PRE_N) shall be **34** or higher, the Mo mass fraction (w_{Mo}) 1.5% or higher **and the N fraction (w_N) 0.14% or higher.**
For "25Cr" super duplex (ferritic/austenitic) stainless steels, the Pitting Resistance Equivalent (PRE_N) shall higher than 40 **and the N fraction (w_N) 0.20% or higher.**
The PRE_N shall be calculated as given in Equation (1):
$$PRE_N = w_{Cr} + 3.3(w_{Mo} + 0.5w_W) + 16w_N \quad (1)$$

where
- w_{Cr} is the mass fraction of chromium in the alloy, expressed as a percentage mass fraction of the total composition;
 - w_{Mo} is the mass fraction of molybdenum in the alloy, expressed as a percentage mass fraction of the total composition;
 - w_W is the mass fraction of tungsten in the alloy, expressed as a percentage mass fraction of the total composition;
 - w_N is the mass fraction of nitrogen in the alloy, expressed as a percentage mass fraction of the total composition.
- 9.4 *Add* Supplementary requirements S1.1 and S1.2 shall apply. Sections 9.2 and 9.3 shall be applicable to the outcomes of the product analysis of S1.1 and S1.2.
- 11.1.1** *Add*
Unless specified otherwise in the purchase order, the Unit of Length (UoL) for pipe is Piece (PC) of single random length (SRL) or double random length (DRL). The specified quantities of random lengths on the purchase order shall be converted to aggregate length on the basis of 6.1 m (20 ft) for single random length and 12.2 m (40 ft) for double random length. To satisfy the purchase order required pipe length, the delivered quantities of random lengths shall amount to at least the calculated aggregate length.

e.g., Pipe pieces of SRL required is 10 no's, calculated aggregate length is 10 x 6.1 m or 10 x 20 ft = 61 m or 200 ft.
- 12.2 *Add* Each pipe shall be visually examined over the entire external surface. The internal surface shall be visually examined from each pipe end. For pipes with a size $\geq$ DN 600 (NPS 24) the entire internal surface shall be visually examined.
- 13.1 *Add:* Tensile tests shall be performed in accordance with ASTM A 370. Room temperature testing shall be carried out in the transverse direction on flattened plate type specimens and in longitudinal direction on plate type specimens without

flattening.

For welded pipe, additional cross weld tensile tests shall be carried out on full wall thickness specimens at room temperature.

The test frequency shall be one duplicate test in both test directions on one pipe representing each lot.

13.3 *Add:* Supplementary requirement S3 shall apply.

13.4 *Modify to read:*

A full circumferential section shall be taken as a sample from one pipe representing each lot (see 13.2). Series of Rockwell C hardness measurements shall be performed in accordance with ASTM E 18 at four locations, 90° apart around the circumference of the section. At each location, triplicate hardness readings shall be taken near the inner surface at mid section and near the outer surface. **Acceptance criteria are as per Table 3.**

For welded pipe only, an additional Vickers HV10 hardness indentations test shall be made in accordance with EN 1043-1 on one full transverse thickness sample from the weldments on one pipe from each lot. Rows of hardness indentations shall be made in accordance with Figure 1 of EN 1043-1, and at mid wall thickness in case the wall thickness is ≥ 6.5 mm (0.26 in). Individual hardness values shall not exceed the equivalent HV10 value in accordance with ASTM A 370 of the criterion for the base material.

13.5 *Add* **Impact testing**

- Charpy impact tests shall be carried out in accordance with ASTM A 370 at a temperature of -50 °C (-58 °F).
- A set of three transverse Charpy test pieces shall be taken from the base material from one pipe representing each lot (for definition of lot see section 9.1 of ASTM A790). Test pieces shall be located at the mid thickness.
- If the pipe wall thickness exceeds 25 mm (0.98 in), additional sets of three Charpy test pieces shall be taken 3 mm (0.12 in) from the internal surface and as close as possible to the outside surface of the pipe.
- The notch of all Charpy pieces shall be perpendicular to the pipe surface.
- Sub-size samples can only be applied, if standard 10 mm x 10 mm (0.39 in x 0.39 in) samples are not possible. Longitudinal samples can only be applied, if transverse samples are not possible.
- The acceptance criteria shall be in accordance with Table 5.
- If the thickness is below 6.5 mm (0.26 in), Charpy impact testing is not practical. The Principal may require additional microstructural checks.

Table 5 *Add*

Table 5 – Acceptance criteria for Charpy impact testing				
Sample size mm (in)	Test direction	Minimum average impact value	Minimum single impact value	Minimum single shear area
10 x 10 (0.39 x 0.39)	Transverse	60 J* (44 ft.lbs)	48 J (36 ft.lbs)	50 %
10 x 10	Longitudinal	90 J	72 J	50 %

(0.39 x 0.39)		(66 ft.lbs)	(53 ft.lbs)	
10 x 7.5 (0.39 x 0.30)	Transverse	48 J (36 ft.lbs)	36 J (26 ft.lbs)	50 %
10 x 7.5 (0.39 x 0.30)	Longitudinal	72 J (53 ft.lbs)	54 J (40 ft.lbs)	50 %
10 x 5 (0.39 x 0.20)	Transverse	30 J (22 ft.lbs)	24 J (18 ft.lbs)	50 %
10 x 5 (0.39 x 0.20)	Longitudinal	46 J (34 ft.lbs)	36 J (26 ft.lbs)	50 %

13.6 Add **Microstructure test**

13.6.1 Add **Ferrite content**

The microstructure and percentage of ferrite phase shall be determined via point counting in accordance with ASTM E 562 on one test piece from one pipe representing each lot (for definition of lot see section 9.1 of ASTM A790).

Errata – 1 (December 2012)

For welded pipe only, full cross-sections of the weld shall be examined as well. Here, the ferrite content shall be measured 1 mm (~~0.039~~ **0.04** in) from both the internal and external surfaces of the parent material, the weld metal and the parent material within 0.2 mm (0.008 in) of the fusion line (FL).

The ferrite content shall be in the range of 40 % - 60 % for the parent material and Heat Affected Zone (HAZ) and in the range of 30 % - 60 % for the weld metal.

13.6.2 Add **Detrimental phases**

The microstructure shall be examined for detrimental phases in accordance with ASTM A 923 Method A on one test piece from one pipe representing each lot (for definition of lot see section 9.1 of ASTM A790). For welded pipe, a full cross-sections of the weld shall be examined as well. The etching method shall be suitable to reveal intermetallic phases (such as sigma phase) and precipitates (such as nitrides). The microstructure shall classify as "unaffected structure" as per section 6 of ASTM A 923. The microstructure shall display a uniform ferrite and austenite phase distribution and shall have no continuous precipitates at the grain boundaries. In addition, the sigma phase content shall not exceed 0.5 %, while the total of intermetallic phases shall not exceed 1.0 %. If these criteria are not met, the pipe shall be rejected and each pipe of the lot investigated.

13.7 Add **Corrosion tests**

13.7.1 Add **Pitting corrosion**

Errata – 2 (December 2012)

The material shall be capable of passing the ferric chloride test in accordance with ASTM G 48, Method A, with the following amendments. This corrosion test shall be performed for product qualification only.

Testing shall be **carried** out on one specimen per lot (for definition of lot see section 9.1 of ASTM A790) including the internal pipe surface and, if applicable, on the weldments. **For weldments, the specimens shall contain** the internal pipe surface, the weld root and the Heat Affected Zone.

- The exposure time shall be 24 hours.

- The test temperature for 22Cr (duplex) steel shall be 25 °C (77 °F) for parent

material and 22 °C (72 °F) for **welds**.

The test temperature for 25Cr (superduplex) steel shall be 40 °C (104 °F) for **parent** material and 35 °C (95 °F) for **welds**.

- A temperature variation not exceeding ± 0.5 °C (0.9 °F) is allowed.
- The surface finish of the test face shall be as produced. Cut faces shall be ground to 1200 grit.
- The evaluation of results shall be via weight loss measurement and macroscopic investigation of the surface. Macrographs obtained by low magnification microscopy shall be provided.

Errata – 3 (December 2012)

- The acceptance criteria shall be a weight loss < 4 g/m² (**0.013 oz/ft²**) and no initiation of localised corrosion > 0.025 mm (**1 mil**) at the test face. Note that only corrosion (e.g., pitting) at the test face counts. If the weight loss is > 4 g/m² (**0.013 oz/ft²**) and it can be positively identified that this is only due to corrosion at the cut faces, the test will be invalid. In this case re-testing shall be carried out on replacement specimens.

13.7.2 *Add* **Stress corrosion cracking**

If specified by the Principal, stress corrosion cracking tests in accordance with ASTM G 38, ASTM G 39 or ISO 15156-3 shall be carried out. Specimens shall be prepared such that the inner surface of the pipe will be loaded at proof stress and exposed to the test environment in the as-produced condition. The dimensions of the specimen, test environment and conditions shall be based on agreement between the Manufacturer and the Principal.

This test is a production qualification test only.

14.1 *Modify to read:*

Each pipe shall be subjected to both the nondestructive electric test and to the hydrostatic test.

14.12 *Add* **Additional NDE**

14.12.1 *Add* **Seamless pipe**

Seamless pipe shall be examined in accordance with Table 6.

Table 6 Add

Table 6 – Examination for seamless pipe			
No.	Non-destructive test	% of lot ¹	Acceptance level
1	Ultrasonic for longitudinal imperfections in accordance with ISO 9303	100	L2
2	Ultrasonic for transverse imperfections in accordance with ISO 9305	100	L2
3	Ultrasonic for laminar imperfections in accordance with ISO 10124	100	B1
4	Ultrasonic for wall thickness in accordance with ISO 10543	100	-
5	Ultrasonic for laminar imperfections at pipe ends in accordance with ISO 11496 ²	100	-
6	Liquid Penetrant of bevel faces in accordance with ISO 12095	100	-
1	Lot as defined in clause 13.2		
2	Tested band shall be a minimum of 50 mm (1.97 in) and shall overlap automatic tested pipe body area by a minimum of 25 mm (0.98 in). The reference standard shall be a flat-bottomed round recess. Examination from the inner surface.		

14.12.2 Add **Welded pipe**

It is noted that duplex materials can be coarse grained and if so, dedicated ultrasonic procedures with compression probes are required. It is the responsibility of the Manufacturer to prove that qualified NDE procedures and personnel are used.

All welds shall be inspected. For seam welds with a wall thickness > 10 mm (0.39 in), (automatic) ultrasonic examination shall be performed, in accordance with Table 7. To cover for the full through-thickness direction of the weld, the number of probes shall be in accordance with Table 8.

For seam welds with a wall thickness ≤ 10 mm (0.39 in), ultrasonic testing per Table 7 may be substituted by film radiography. Testing and acceptance criteria shall be in accordance with ISO 12096, while the image quality class shall be R1, using a wire type image quality indicator.

Table 7 Add

Table 7 – Examination for welded pipe			
No.	Non-destructive test	% of lot ¹	Acceptance level
1	Ultrasonic for longitudinal imperfections in the weld seam in accordance with ISO 9303 or ISO 9764 ²	100	L2
2	Ultrasonic for laminar imperfections in the pipe body in accordance with ISO 12094 ³	100	E1
3	Ultrasonic for laminar imperfections in the plate / strip edges adjacent to the weld in accordance with ISO 13663 ⁴	100	E1
4	Testing of the weld seam at pipe ends not covered by automatic testing: manual ultrasonic testing based on the same principles as in item 1, in accordance with ISO 9765 or ISO 12096	100	-
5	Ultrasonic for laminar imperfections at the pipe ends in accordance with ISO 11496 ⁵	100	-
6	Liquid Penetrant testing of the pipe bevel end in accordance with ISO 12095	100	-
1 Lot as defined in clause 13.2 2 The calibration defect shall be on both the internal and external surface. 3 The minimum coverage shall be 25 %. The edge band shall be 25 mm (0.98 in) from final plate / strip edge. Reference standard shall be a flat-bottomed round recess. 4 Reference standard shall be a flat-bottomed round recess. 5 Tested band shall be a minimum of 50 mm (1.97 in) and shall overlap automatic tested pipe body area by a minimum of 25 mm (0.98 in). The reference standard shall be a flat-bottomed round recess. Examination from the inner surface.			

Table 8 Add

Table 8 – Number of probes required for ultrasonic test			
Wall thickness WT mm (in)	Longitudinal defect detection: number of probes per zone of the weld (at both sides of the longitudinal weld)		
	Inner zone	Mid portion	Outer zone
< 12 (0.47)	One	-	One
12 ≤ WT ≤ 17.9 (0.47 ≤ WT ≤ 0.70)	One	One pair in tandem (45°) centered at midwall position ¹	One
1 Reference reflector 3 mm (0.12 in) flat bottom hole			

15.2

Modify to read:

Weld repairs of the weld seam shall not exceed 5 % of the seam length.

16.1

Add:

In addition, marking shall also include the nominal pipe size (DN), and the pipe schedule number or specified wall thickness (mm).

Marking shall also include the charge number and, where applicable, the heat number.

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Add

Certification

Unless specified otherwise, inspection and test certificates shall be supplied to the Principal.

PART III REFERENCES

In this MESC SPE, 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. Most of the referenced external standards are available to Shell staff on the SWW (Shell Wide Web) at <http://sww05.europe.shell.com/standards>.

AMERICAN STANDARDS

Standard Test Methods and Definitions for Mechanical Testing of Steel Products	ASTM A 370
Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe	ASTM A 790:11
Standard Test Method for Detecting Detrimental Intermetallic Phase in Duplex Austenitic/Ferritic Stainless Steels	ASTM A 923
Standard Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials	ASTM E 18
Standard Test Method for Determining Volume Fraction by Systematic Manual Point Cou	ASTM E 562
Standard Practice for Making and Using C-Ring Stress-Corrosion Test Specimens	ASTM G 38
Standard Practice for Preparation and Use of Bent-Beam Stress-Corrosion Test Specimens	ASTM G 39
Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution	ASTM G 48

Issued by:
American Society for Testing and Materials
100 Barr Harbor Drive, West Conshohocken
PA 19428-2959
USA

EUROPEAN STANDARDS

Destructive Tests on Welds in Metallic Materials Hardness Testing – Part 1: Hardness Test on Arc Welded Joints	EN 1043-1
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Issued by:
Comité Européen de Normalisation
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Rue de Stassart 36
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INTERNATIONAL STANDARDS

Seamless and Welded (Except Submerged Arc- Welded) Steel Tubes for Pressure Purposes - Full Peripheral Ultrasonic Testing for the Detection of Longitudinal Imperfections	ISO 9303
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Seamless Steel Tubes for Pressure Purposes - Full Peripheral Ultrasonic Testing for the Detection of Transverse Imperfections	ISO 9305
Electric Resistance and Induction Welded Steel Tubes for Pressure Purposes - Ultrasonic Testing of the Weld Seam for the Detection of Longitudinal Imperfections	ISO 9764
Submerged Arc-Welded Steel Tubes for Pressure Purposes - Ultrasonic Testing of the Weld Seam for the Detection of Longitudinal and/or Transverse Imperfections	ISO 9765
Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes. Ultrasonic testing for the detection of laminar imperfections	ISO 10124
Seamless and hot-stretch-reduced welded steel tubes for pressure purposes. Ultrasonic thickness testing	ISO 10543
Seamless and Welded Steel Tubes for Pressure Purposes - Ultrasonic Testing of Tube Ends for the Detection of Laminar Imperfections	ISO 11496
Welded Steel Tubes for Pressure Purposes - Ultrasonic Testing for the Detection of Laminar Imperfections in Strips/Plates Used in the Manufacture of Welded Tubes	ISO 12094
Seamless and Welded Steel Tubes for Pressure Purposes - Liquid Penetrant Testing	ISO 12095
Submerged Arc-Welded Steel Tubes for Pressure Purposes - Radiographic Testing of the Weld Seam for the Detection of Imperfections	ISO 12096
Welded Steel Tubes for Pressure Purposes - Ultrasonic Testing of the Area Adjacent to the Weld Seam for the Detection of Laminar Imperfections	ISO 13663
Petroleum and natural gas industries — Materials for use in H ₂ S-containing environments in oil and gas production Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys	ISO 15156-3

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