



## Bayu Undan / Darwin LNG Facilities Technical Delivery Terms

<b>Material Description:</b>	<b>Pipes, Flanges &amp; Fittings</b>		
<b>Doc No:</b>	<b>TDT 06</b>	<b>Rev:</b>	<b>3</b>
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### 1 SCOPE

This document outlines the general technical requirements for the supply of Pipe, Fittings & Flanges for the Santos Bayu-Undan and Darwin LNG Facilities.

Specifically, pipe and piping materials shall be manufactured under the general requirements of the following codes and standards:

ASME B16.5	Pipe, Flanges and Flange Fittings.
ASME B16.9	Factory Made Wrought Steel Buttwelding Fittings.
ASME B16.25	Buttwelding Ends.
ASME B16.36	Steel Orifice Flanges, Class 300, 600, 900, 1500 and 2500.
ASME B16.47	Large Diameter Steel Flanges NPS 26 Through NPS 60.
ASME B36.10	Welded and Seamless Wrought Steel Pipe.
ASME B36.19	Stainless Steel Pipe.
ASME B31.3	Process Piping.
ASTM A733	Welded & Seamless Carbon Steel & Austenitic Stainless Steel Pipe Nipples.
EEMUA	90/10 Copper Nickel Alloy Piping for Offshore Applications Specification: Tubes Seamless and Welded Pub No. 144 – 1987. Specification: Fittings Pub No. 146 – 1987. Specification: Flanges Composite and Solid Pub No. 145 – 1987.
EN 10204	Metallic Products – Types of inspection documents.
MSS-SP-75	Specification for High Test Wrought Welding Fittings
MSS-SP-97	Integrally Reinforced Forged Branch Outlet Fittings Socket Welding, Threaded and Buttwelding Ends.
NACE MR 0175	Sulfide Stress Cracking Resistant Metallic Materials for Oil Field Equipment.

## **2 GENERAL REQUIREMENTS**

### **2.1 MATERIALS**

The materials shall be as per the identified ASTM material specifications in this document or equivalent or superior. Supplemental and modified requirements to the identified ASTM material specifications are outlined under each item as necessary. Acceptable alternatives for stainless steel and duplex materials are detailed below. All titanium pipe and fittings shall be seamless.

#### **2.1.1 Carbon Steel Materials**

##### **a) Pipe**

For items specified as seamless ASTM A53/A106/API 5L (Triple Stamped), ASTM A671/672 EFW pipes with 100% radiography is acceptable as an alternative material with written approval from Santos. ASTM API 5L Gr B SAW pipes with 100% radiography are only acceptable up to and including 250mm diameter.

All radiography shall be carried out by film techniques. Real time radiography is not acceptable.

##### **b) Fittings**

For all items specified as seamless ASTM A234 grade WPB, two welded alternatives would be acceptable.

1. For fittings made from welded mother pipe, the mother pipe must comply with the details in 2.1.1 a) above. No further radiography required on the finished fittings. Certification must include the mother pipe material.
2. For fittings welded from pressed plate, the fittings must comply with ASTM A234 grade WPBW with 100 % radiography by film techniques.

#### **2.1.2 Stainless Materials**

##### **a) Pipe**

For items specified as seamless ASTM A312-TP316, welded ASTM A358-TP316 class 1 with 100% radiography is acceptable as an alternative material with written approval from Santos. Welded ASTM A312 with 100% radiography and ASTM A358 WT tolerances are only acceptable up to and including 250mm diameter.

All radiography shall be carried out by film techniques. Real time radiography is not acceptable.

##### **b) Fittings**

For all items specified as seamless ASTM A403 grade WP316, two welded alternatives would be acceptable.

1. For fittings made from welded mother pipe, the mother pipe must comply with the details in 2.2.1 a) above. No further radiography required on the finished fittings. Certification must include the mother pipe material.
2. For fittings welded from pressed plate, the fittings must comply with ASTM A403 grade WP316 WP-WX with 100 % radiography by film techniques.

### **2.1.3 Duplex Materials**

#### **a) Pipe**

For items specified as seamless A790-S31803, welded ASTM A928-S31803 class 1 with 100% radiography and impact tests in the weld & HAZ at minus 50° C is acceptable as an alternative material with written approval from Santos.

All radiography shall be carried out by film techniques. Real time radiography is not acceptable.

#### **b) Fittings**

For all items specified as seamless ASTM A815-S31803, two welded alternatives would be acceptable.

1. For fittings made from welded mother pipe, the mother pipe must comply with the details in 2.1.2 a) above. No further radiography required on the finished fittings. Certification must include the mother pipe material certificates.
2. For fittings welded from pressed plate, the fittings must comply with ASTM A815-S31803 WP-WX with 100 % radiography by film techniques and impact tests in the weld and HAZ at minus 50° C.

All duplex fittings, both seamless and welded, shall be subject to 100% dye penetrant examination.

## **2.2 DIMENSIONAL STANDARDS**

The dimensions of pipes and fittings shall be as per the relevant dimensional standards listed in ASME B31.3 except as modified herein.

## **2.3 FLANGE AND GASKET FACING FINISHES**

Flange sizes up to DN600 shall be to ASME B16.5. Flanges in sizes above DN600 shall be to ASME B16.47 Class B. RTJ flanges larger than DN600, in class 900 rating and above, shall be to ASME B16.47 Series A.

Flange gasket surface finishes shall be in accordance with the following:

All Classes – Smooth Spiral finish, with a surface roughness of between RA 3.2µm and 6.3µm.  
RTJ – Smooth Finish, with a side wall surface roughness of between RA 0.4µm and 1.6µm.

## **2.4 ORIFICE FLANGES**

Orifice flanges shall be in accordance with ASME B16.36.

## **2.5 WELD BEVEL ENDS**

Bevel ends for pipes, flanges and fittings shall be in accordance with ASME B16.25.

## **2.6 INTEGRALLY REINFORCED FORGED BRANCH OUTLET FITTINGS**

The design of Integrally Reinforced Forged Branch Outlet Fittings shall be documented to demonstrate compliance with ASME B31.3 para 304.3.2, Appendix D Table D300 and fulfil the following requirements:

- Integrally Reinforced Outlet Fitting dimensions shall be in accordance with MSS SP97, unless stated otherwise in the Material Requisition.
- The design shall be supported by area Reinforcement Calculations and same shall be submitted for the approval. The design shall not be dependent on weld material to provide the necessary area replacement required.
- Burst Test certification shall be submitted for all Reinforced Outlet Fittings and shall be in accordance with MSS SP97, Annex B.
- The internal bore of the Integrally Reinforced Outlet Fitting shall be tapered with a maximum slope of 30 degrees to match branch bore.
- Flanged Integrally Reinforced Outlet Fittings shall be in accordance with ASME B16.5 or as stated in the Material Requisition.
- All Integrally Reinforced Outlet Fittings shall be forged as close as practicable to final shape with the exception of finish machining. Fittings machined from forged bar or forged rings are **NOT** acceptable.
- Repair by welding is not permitted.

## **2.7 APPLICABILITY OF NACE MR0175 REQUIREMENTS**

Piping designated for Sour Service shall meet the requirements of NACE MR0175 in addition to base material specification and additional requirements specified above. Such requirements will be identified in the description in the purchase order. Material certificate/compliance statement shall clearly indicate the required property and NACE compliance requirement and the compliance details against each of those specified details. For Pipes and Fittings specified as “Sour”/NACE MR0175 applicable, the sulphur content shall not exceed 0.010%.

## **2.8 NON DESTRUCTIVE EXAMINATION**

General NDE methods, sampling frequency and acceptance criteria shall be in accordance with the relevant product specification and the supplementary requirements detailed below.

1. Hardness tests shall be carried out in accordance with the supplementary requirement of the product specification on 10% of each heat. Hardness values shall be in accordance with NACE MR0175.
2. 100% Visual examination. Any irregularities shall be further examined by MT or PT as applicable.
3. 100% of ferritic steel pipe, butt weld fittings and branch fittings with wall thickness greater than Sch 80, flanges and flanged components ASME 600# and above, shall be examined by MT.
4. Longitudinal seams of welded pipe and welded fittings shall be subjected to 100% RT.
5. All Duplex Fittings and the weld neck areas of duplex flanges shall be subject to PT.

## **2.9 IMPACT TESTING**

Impact testing shall be carried out in accordance with ASME B31.3 para 323.3.

Welded Duplex Pipe and Fittings – specimens from the Weld Metal Deposit and the Heat Affected Zone shall be Impact Tested at minus 50° C. The minimum absorbed energy shall be 35 Joules minimum average and 28 Joules minimum individual.

All other materials shall be Impact Tested as required by the Product Standard.

## **2.10 MARKING REQUIREMENTS**

In addition to the product standard markings, the purchase order item code shall be included. When identified as for “Sour Service”, the letter “N” shall be marked after the item code. Small bore fittings (DN40 and smaller) shall be wired together (SS 316 wire) in lots not exceeding 20Kg. All markings which are in addition or are supplemental to the product specification shall be clearly stamped on a stainless steel tag which shall be of adequate size to permit the use of characters 3mm high. Paint or ink shall not contain metal or metal salts such as zinc, lead, copper or tin, which could cause corrosion attack on heating. When used on stainless steel materials, zinc or lead pigments are not permitted and paints or inks shall be chloride free.

For integrally reinforced forged branch outlet fittings, weld lines shall be marked on the outlet fittings.

**Location and Type of Marking.**

ITEM TYPE	MARKING TYPE	MARKING LOCATION
All Cu-Ni-Fe items, plus pipe & fittings for all components who's thickness is below 5mm.	Vibro-etching.	Pipe: 250mm from one end; paint shall be applied to marked area's to preserve but not obscure markings.
High Yield Carbon Steel, Duplex and Stainless Steel 316 Pipe and Fittings, and Fibre Gaskets.	Waterproof paint or ink stencil.	Elbows: Centrally at 90° to the inner radius about the symmetrical centreline.
All other Pipe, Fittings, Flanges and Metal Containing gaskets.	Round nose low stress stamp.	Tee's: About the symmetrical centreline on the side of the Tee. Caps: Centrally on dome. Reducers: Along the centreline (Eccentric reducers marked on the flat side). Stub Ends: Along the centreline. Flanges: On the outer rim. S.W. Gaskets: On the outer centering ring. RTJ Gaskets: On the outer rim. Fibre Gaskets: On label attached to gasket.
Bolting.	Round nose low stress stamp.	7/8" Dia and above: Heat and heat treatment batch number plus bolt/nut grade on one end, nuts on one face.
	Stamped metal tag securely affixed to packaging with SS wire.	7/8" Dia and above: All the required marking not covered by the above stamping. ¾" and below: All required marking.

**2.11 CERTIFICATION AND DOCUMENTATION**

All piping materials shall be supplied with EN 10204 3.1 material certificates for each batch/heat traceable to the actual items/components being supplied.

Bayu Undan and Darwin LNG Facilities  
 Technical Delivery Terms for the supply of Pipes, Flanges & Fittings

All the documents relating to quality assurance and quality control including certifications shall be in English and readily legible. Documents provided in other languages or illegible shall not be accepted and shall be referred to Santos before clearing final inspection.

For Integrally Reinforced forge branch outlet fittings, Supplier shall submit following documents to Santos for approval ;

- Area reinforcement calculations including required weld sizing
- Burst Test Certification ( Type Test)

## 2.12 COLOUR CODING OF PIPING

The items shall be colour identified for the purpose s of transport, storage and handling. The colour identification shall be carried out in compliance with the table below:

Material	Visual Colour	BS4800 No and Colour
Pipe ASTM A106 Gr B	Powder Blue	18 E 49 Blue
Pipe API X52	Yellow	06 D 43 Yellow-red
Pipe API X60	Cream	10 C 31 Yellow
Pipe API X65	Dark Blue	20 D 45 Purple-blue
Galvanised Carbon Steel	Self Colour	
ASTM A333 Gr 6	Light Green	14 E 51 Green
ASTM A671 C65 CL32		
Duplex SS (UNS S31803)	Grey Blue	18 C 35 Blue
Austenitic SS 316	Light Brown	08 C 37 Yellow-red
Cu-Ni-Fe UNS C7060X	Self Colour	
Titanium ASTM B861 Gr 2	Self Colour	
GRE	Self Colour	

1. Colour coding shall not obliterate other markings.
2. Pipe and Fittings shall be coded by a stripe along the entire length, 12 mm wide for sizes 1½” and smaller, 25mm for sizes 2” and larger.
3. Flanges shall be colour coded by painting the complete outer rim.

## 2.13 PRESERVATION AND SHIPPING REQUIREMENTS

### 2.13.1 General

Material shall be suitably packed to prevent damage during handling or loss or damage in transit.

Preservation shall be applied so that, provided the package remains unopened, undamaged and handled in accordance with the vendor’s marking and shipping instructions, negligible degradation is permitted for a minimum period of twelve months from date of despatch from the vendor’s works.

Crating and packages shall be suitable for opening and resealing without difficulty or damage.

Preservation shall be such that if the packaging is disturbed, then negligible degradation is permitted for a minimum period of 6 months or 12 months from despatch from the vendor’s works, whichever is the sooner.

Timber material shall be treated/fumigated to prevent infestation by insects or similar for all material destined for Darwin (Australia). This is to meet quarantine regulations and prevent impounding by customs in addition to preserving the timber whilst in tropical storage at the delivery point.

Crating and packages shall be marked with clear handling, storage and warning instructions to protect against damage to the preservation applied.

Bayu Undan and Darwin LNG Facilities  
 Technical Delivery Terms for the supply of Pipes, Flanges & Fittings

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### 2.13.2 Specific Item Requirements

#### Flanges.

All items 6" DN and below, and all Copper Nickel items of any size shall be crated.  
Items 8"DN and larger may be shipped separately or securely fastened together in batches of 3 cubic metres.

All bevel ends and flange facings shall be protected with Shell Ensis MD or equal corrosion protecting fluid. Flange facings shall be further protected by securely attached wooden or plastic covers. Bevel ends shall be further protected by plastic caps.

Galvanised Carbon Steel "Backing Flange", Spectacle Plates, Blinds and Composite Blind Flanges etc shall be galvanised and Painted in accordance with "System 5" as per specification H8-GEN-00-075-S01-0100. Excluding the CuNi clad area.

### **Pipe.**

Bevel ends shall be protected with Shell Ensis MD or equal corrosion protection fluid, covered by plastic cap ends. Exposed threads shall be protected using plastic end caps.

All Copper Nickel pipe and tubing shall be crated.

## 2.14 SCHEDULE OF SUPPLEMENTARY REQUIREMENTS

### 2.14.1 PRODUCT SPECIFICATION

MATERIAL TYPE	COMPONENT FORM	PRODUCT SPECIFICATION	SUPPLEMENTARY REQUIREMENTS			
			MECH	CHEM	NDE	FINISH
Carbon Steel	Pipe	ASTM A106 Gr B	Note 11 & 12	Note 5		
Carbon Steel	Pipe	ASTM A671	Note 1 & 11			
Carbon Steel	Fitting	ASTM A234 Gr WPB				
Carbon Steel	Forging	ASTM A105 Norm				
LT Carbon Steel	Pipe	ASTM A333 Gr 6	Note 11 & 12	Note 5		
LT Carbon Steel	Fitting	ASTM A420 WPL 6				
LT Carbon Steel	Forging	ASTM A350 LF2				
Galv Carbon Steel	Pipe	ASTM A106 Gr B	Note 11			
Galv Carbon Steel	Fitting	ASTM A234 Gr WPB				
Galv Carbon Steel	Forging	ASTM A105 Norm				
Austenitic Stainless Steel	Pipe	ASTM A312 TP316	Note 1, 2, 11	Note 2 & 3		
Austenitic Stainless Steel	Fitting	ASTM A403 WP316	Note 2	Note 2 & 3		
Austenitic Stainless Steel	Forging	ASTM A182 Gr F316	Note 2	Note 2 & 3		
Duplex Stainless Steel	Pipe	ASTM A790 (S31803)	Note 1, 8, 11	Note 7	Note 9	
Duplex Stainless Steel	Fitting	ASTM A815 (S31803)	Note 8	Note 7	Note 9	
Duplex Stainless Steel	Forging	ASTM A182 Gr F51	Note 8	Note 7		
Titanium	Pipe	ASTM B861 Gr 2	Note 11			
Titanium	Fitting	ASTM B363 WP T2	Note 1			
Titanium	Forging	ASTM B381 Gr F2				
Copper Nickel	Pipe	UNS C7060X			Note 10	



**Notes:**

1. All welded pipe and fittings shall have a minimum joint efficiency factor of 1.
2. All Austenitic Stainless Steel shall be dual stamped, i.e. carbon content of 316L and mechanical properties of 316.
3. All tubular Austenitic Stainless Steel pipe and fittings shall have a minimum molybdenum content of between 2.0% and 3.0% Mo.
4. All Pipes shall be supplied non-oiled and non-expanded.
5. ASTM A106 supplementary requirements S5 shall apply but the carbon equivalent (CE) shall be 0.43 maximum. Carbon content shall be 0.23% maximum.
6. All materials designated, as being used for sour service shall meet all relevant requirements as prescribed by NACE MR0175.
7. UNS S31803 with minimum 0.15% N and PREN  $\geq 33$ .
8. UNS S31803 % Ferrite in final heat treated condition shall be between 40 – 60%.
9. UNS S31803 Zero Sigma phase. For welded Pipe and Fittings.
10. Eddy Current examination is acceptable in lieu of hydrostatic testing.
11. Hydrostatic testing is required.
12. Seamless Pipe manufactured by the “Hot Pilger” process is not acceptable regardless of the size. This includes fittings manufactured from “Hot Pilger pipe”.