



Bayu Undan / Darwin LNG Facilities

Technical Delivery Terms

Material Description:	Coated Alloy Steel Bolting		
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1 SCOPE

This document outlines the general technical requirements for the supply of coated alloy steel bolting components for piping for the Santos Bayu-Undan and Darwin LNG Facilities. This does not include bolting components for structural applications covered by TDT07.

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

AS 1580	Methods of Test for Paints and Related Materials.
AS 1627.6	Phosphate Treatment of Iron and Steel Surfaces.
AS 1897	Electroplated Coatings on Threaded Components.
AS 2331	Methods of Test for Metallic and Related Coatings.
AS CK13	Code of Recommended Practice for Preparation of Metal Surfaces for Electroplating.
ASME B1.1	Unified Inch Screw Threads (UN & UNR Thread Form).
ASME B1.2	Gauges and Gauging of Unified Screw Threads.
ASTM A193	Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service.
ASTM A194	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service.
ASTM A320	Alloy Steel Bolting Materials for Low Temperature Service.
ASTM A700	Packaging, Marking and Loading Methods for Steel Products for Domestic Shipment.
ASTM DS – 56 G	Metals & Alloys in the Unified Numbering System.
EN 10204	Metallic Products – Types of inspection documents.

Additionally, the bolt description shall clearly indicate the nominal diameter (in inches), pitch (in threads per inch - TPI), length (in mm), material specification, and the required number of nuts (generally 2 per studbolt). Washers shall not be provided, unless specifically requested for hold down bolts for equipment.

2 EXCEPTIONS AND ADDITIONAL REQUIREMENTS

- Hexagon bolts shall have a washer face on the underside of the head.
- Stud bolts shall be threaded on the entire length. The length of the bolt is measured as threaded length excluding the height of the end points.
- Studbolt thread tolerance shall be Class 2A in accordance with ASME B1.2, or equivalent in AS1214 and AS4680.
- Nuts shall be of heavy hexagonal series in accordance with ASME B18.2.2 with minimum height equal to the diameter of the bolt.
- Nuts shall have a chamfer of 15 degrees to 30 degrees on both faces.
- Nut thread tolerance shall be Class 2B in accordance with ASME B1.2, or equivalent in AS1214 and AS4680.
- If heat treatment is required to achieve the mechanical properties as stated herein, the threads shall be formed after such heat treatment.
- Thread shall be of 'unified system threads' in accordance with ASME B1.1 and shall be formed by rolling. Machine cut threading is not permitted.
- Threading shall be Unified Coarse (UNC) finish for stud bolts up to and including 1" diameter. Stud bolts of diameter size greater than 1" shall be 8UN selected finish (equivalent to a constant pitch of 8 threads per inch - TPI)

3 MATERIALS

Materials and mechanical properties of all alloy steel bolting shall be in accordance with the code and grade requirements specified hereunder.

Stud Bolt: ASTM A193-B7, ASTM A320-L7 for low temperature service, and ASTM A193 B16 for very high temperature service (Darwin LNG only)

Nut: ASTM A194-2H, ASTM A194-7 [S3] for low temperature service, and ASTM A194-4 for very high temperature service (Darwin LNG only)

Failure of any of the tensile tests or the proof load tests shall constitute rejection of the entire batch.

4 CERTIFICATION

All materials shall be supplied with EN 10204 type 3.1 specific test certificates for each batch/heat. In addition, bolting materials shall also be supplied with EN 10204 – 2.1 Certificates of Conformity related to the coating requirements. These certificates shall relate to batches of bolts to typical test results obtained (i.e. EN 10204 – 2.2 certificates). The Supplier shall retain all specific coating test results on file which may be subject to audit by Santos.

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.

5 PACKING, SUPPLY AND DOCUMENTATION

The stud bolts and nuts shall be preserved, packed and supplied in accordance with specification “Export Packing & Marking” (ALL/SUP/LOG/PRO/2000). Shipping documentation shall be in accordance with specification “Shipping Documentation Requirements” (ALL/SUP/LOG/WKI/2000). Both of these specifications form part of the standard purchasing requirements for Santos and are normally issued with the request for quotation and purchase order.

In addition each material and each size shall be packed separately. The Supplier shall provide an export packing and marking procedure for approval by Santos.

6 COATINGS

6.1 Piping Bolting Components

Piping bolting components for the Bayu Undan offshore facilities shall be supplied:

- Cadmium plated in accordance with Section 6.2 and fluoroplastic (PTFE) coated in accordance with Section 6.3 for use at operating temperatures below 200°C
- Phosphate pre-treatment in accordance with Section 6.4 and PTFE coated in accordance with Section 6.3 for use at operating temperatures above 200°C

Piping bolting components for the Darwin LNG facility shall be supplied:

- Cadmium plated in accordance with Section 6.2 and fluoroplastic (PTFE) coated in accordance with Section 6.3 for use at operating temperatures below 200°C
- Phosphate pre-treatment in accordance with Section 6.4 and PTFE coated in accordance with Section 6.3 for use at operating temperatures above 200°C
- Phosphate pre-treatment in accordance with Section 6.4 with an oil top coating for all A193 B16 bolting

Each stud bolt and nut shall be colour coded before packing as follows:

6.1.1 Bolting Colour Coding Table

Material	Colour Code
Alloy steel bolting ASTM A193 B7/A194 2H Cadmium + PTFE (up to 200°C)	Green
Alloy steel bolting ASTM A193 B7/A194 2H Phosphate + PTFE (greater than 200°C up to 400°C)	Black
Low temperature alloy steel bolting ASTM A320-L7 / A194-7 Cadmium + PTFE (up to 200°C)	Blue
Low temperature alloy steel bolting ASTM A320-L7 / A194 -7 Phosphate + PTFE (greater than 200°C up to 370°C)	Red
Alloy steel bolting ASTM A193 B16/A194 -4 Phosphate + oil (greater than 400°C)	-

NB. The standard stamping required by the material specification shall be legible after the bolting components have been coated.

6.2 Cadmium Plating of Bolting Components

This section defines the technical requirements for the application of cadmium plating of bolting components in service up to 200°C.

The supplier shall verify that the manufacturing tolerance is adequate to accommodate the proposed coating thickness without interfering with the fit of the nut by a method of trial fitting. Thread accuracy shall be such that all plated nuts of a particular size can be hand threaded onto the full length of all plated bolts of that same size.

6.2.1 Requirements for Cadmium Plating

The plating shall be carried out in accordance with the “Barrel Method”. The surface of all bolting components which require plating shall be prepared and conform to the requirements of Code of Practice AS CK13.

The plating applied to the bolting components shall contain not less than 98.5% cadmium and shall be free from all mercury. The total impurities excluding zinc and nickel shall not exceed 0.5%.

The bolting components shall be heavy cadmium plated in accordance with AS 1897 Service Condition 3 (severe). After plating, all bolting components shall be chromate treated in accordance with AS 1897 Type C – (yellow iridescent). The passivated cadmium plated components shall not be handled for 24 hours to allow for hardening of the chromate conversion plating.

6.2.2 Inspection and Testing

Sampling for visual examination and plating thickness testing shall be carried out in accordance with the recommended sampling procedure given in Appendix E of AS 1897. If the maximum number of defective products is above the specified amount, then the Supplier shall advise Santos of the corrective action they propose. Santos reserves the right to reject the batch until corrective action has been approved.

The plating shall be free from misses, high spots or other defects likely to compromise plating performance. Any misses and high spots which, after final coating, would affect the ability of carrying out the thread fit shall be unacceptable.

The required number of samples shall be tested to verify the plating thickness. The plating thickness tests shall be determined by one of the methods described in AS 2331.1. The testing shall be carried out on bolt ends and nut faces. The plating thickness shall not be less than that required by code. In the event of dispute, the micro-sectioning method shall be used in accordance with AS 2331.1.1.

Plating adhesion tests shall be carried out in accordance with the burnishing test method described in AS 2331.4.1. The test shall be carried out on the bolt ends and nut faces of test bolts or on test plates for each batch. The plating shall remain adherent to the substrate.

6.3 PTFE Coating`

PTFE shall be applied over cadmium plating in accordance with 6.2 above for bolting materials that will be used at temperatures up to 200°C, or over a phosphate pre-treatment for temperatures greater than 200°C (see below).

6.3.1 Requirements for Fluoroplastic (PTFE) Coating

For service applications up to 200°C, the bolting materials shall undergo a Cadmium plating pre-treatment in accordance with 6.2 above.

For service applications greater than 200°C, the pre-treatment shall comprise a phosphate treatment in accordance with Section 6.4.

6.3.2 PTFE Coating Materials

The coating for the bolting components shall be as follows:

Xylan Series 1070 or Series 1424 – Manufactured by the Whitford Corporation

Alternative coatings may be acceptable but shall be similar to the specified material and shall contain polytetrafluorethylene together with polyamide/imide ester and colouring pigment and shall be the base cure type. Where alternative coating materials are proposed, the Supplier shall submit full details and obtain Santos Approval in writing before coating commences.

6.3.3 Thickness of Coating

The dry film thickness of the PTFE coating on the bolting components shall not be less than 25 microns and not greater than 40 microns.

6.3.4 Inspection and Testing

Sampling for visual examination and coating thickness testing shall be carried out in accordance with the recommended sampling procedure given in Appendix E of AS 1897.

If the maximum number of defective products is above the specified amount, then the Supplier shall advise Santos of the corrective action they propose. Principal reserves the right to reject the batch until corrective action has been approved.

The cured PTFE coating shall be free from runs, sags, misses or other defects likely to compromise coating performance or affect thread fit.

The required number of samples shall be tested for coating thickness. The coating thickness test shall be in accordance with AS 1580 Method 108.1.

The bolting components shall be subjected to a hardness test in accordance with AS 1580 Method 405.1. The tests shall be carried out on the bolt ends and nut faces. The coating hardness shall be Grade F minimum.

The coating adhesion tests shall be carried out in accordance with AS 1580 Method 408.2 “Intersecting Cut Method”. The tests shall be carried out on the bolt ends and nut faces of test bolts or on test plates prepared as agreed for each batch. The coating adhesion shall have a rating of 4 or better.

Coating records shall be integrated with certification records for the overall bolting manufacture.

The PTFE coating shall be colour coded as per table 6.1.1.

6.4 Phosphate Pre-treatment

6.4.1 Requirements for Phosphate Pre-treatment

Phosphate pre-treatment shall be performed in accordance with AS 1627.6. For bolting to be PTFE coated, a *Class A1* pre-treatment shall be utilised. For bolting to be oil coated, a *Class B* pre-treatment shall be utilised.

6.4.2 Inspection and Testing

Sampling for visual examination and coating thickness testing shall be carried out in accordance with the recommended sampling procedure given in Appendix E of AS1897. If the maximum number of defective products is above the specified amount, then the Supplier shall advise Santos of the corrective action they propose. Santos reserves the right to reject the batch until corrective action has been approved.

The required number of samples shall be tested to verify the coating mass. The tests shall be determined by one of the methods described in Appendix B of AS 1627.6. The coating mass shall not be less than that required by the specified coating class.