

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

CRA CLAD OR LINED STEEL PIPE (AMENDMENTS/SUPPLEMENTS TO API SPEC 5LD)

PTS 31.40.20.32

DECEMBER 2009



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PTS No:	31.40.20.32
PTS Title:	CRA CLAD OR LINED STEEL PIPE (AMENDMENTS/SUPPLEMENTS TO API SPEC 5LD)

This revision of **PTS 31.40.20.32– CRA CLAD OR LINED STEEL PIPE (AMENDMENTS/SUPPLEMENTS TO API SPEC 5LD) (December 2009, Revision 1)** has been updated to incorporate PETRONAS Lessons Learnt, Best Practice and new information issued by relevant industry code and standards. All updates in the document are highlighted in *italic font*.

The previous version of this PTS 31.40.20.32 (**October 1995**) will be removed from PTS binder / e-repository from herein onwards.

The custodian of this PTS is:

Name: Tan Yew Min

Tel. No: 603 2783 6218

Please direct any questions regarding this PTS to the above-named.

Document Approval

	Name	Designation	Date	Signature
Prepared/ Reviewed	Fairul Azmi bin Kamaruddin	Engineer (Corrosion)	24/12/2009	
Approver	Tan Yew Min	Staff Engineer (Material)	29/12/09	
	Zamaluddin Ali	Principal Engineer (Inspection)	11/01/10	
Verified	Che Wan Ibrahim Che Wan Sudin	Head of MCI	24/12/2009	
Verified	Pau Kiew Huai	General Manager, Engineering, GTS	19.1.2010	
Endorsed		Senior General Manager, GTS	19.1.2010	

Revision History

Rev No.	Reviewed by	Approved by	Date
1	Fairul Azmi bin Kamaruddin	Tan Yew Min	December 2009

Summary of Amendments

- 1) This PTS is updated to reflect the latest changes in API 5LD. The earlier PTS of the same number dated October 1995 is based on API 5LD First edition published in 1993. The referred standards have been updated twice in December 1998 and September 2009. This PTS is amended based on the latest edition of API 5LD (3rd edition, issued in September 2009)
- 2) The contents and arrangement of the chapter in API 5LD 2009 has change noticeably since it was first published and this PTS structure is revised corresponding to the changes made in the mentioned document.
- 3) The list below will mentioned the changes made in the latest edition of API 5LD at the date of this review conducted. The list below highlights the major changes made from the previous PTS version:
 - a. Reallocation of PTS chapter according to the structure changes in the third edition API 5LD.
 - b. The main reference for this PTS previous version also covers centrifugal pipe in its scope. The scope of this PTS will no longer include centrifugally cast pipe following its removal from the latest edition of API 5LD
 - c. Some of the chapter from this previous PTS version has referred directly to API 5L published at November 1992 that have also been reviewed and have some of the chapter referred by PTS have been removed in the latest edition of API 5L published in February 2009. Since the referred chapter in API 5L no longer existed, the corresponding chapter in this PTS is also removed.

PREFACE

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They are based on the experience acquired during the involvement with the design, construction, operation and maintenance of processing units and facilities. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good technical practice to be applied by PETRONAS' OPU in oil and gas production facilities, refineries, gas processing plants, chemical plants, marketing facilities or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where PTS may not cover every requirement or diversity of condition at each locality. The system of PTS is expected to be sufficiently flexible to allow individual operating units to adapt the information set forth in PTS to their own environment and requirements.

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PART I INTRODUCTION

1.1 SCOPE

This new PTS gives the minimum requirements for the purchase of seamless and welded corrosion resistant alloy (CRA) clad or lined steel pipe for both sour and non-sour service. It is based on API Spec 5LD, third edition, September 1, 2009. Part II of this PTS gives amendments and supplements to clauses of API Spec 5LD which are considered necessary as a contribution to ensuring pipeline integrity in accordance with PETRONAS Group requirements.

The requirements for carbon steel base material in this PTS reflect the requirements of API Spec 5L, as amended by PTS 31.40.20.30.

1.2 DISTRIBUTION, APPLICABILITY AND REGULATORY CONSIDERATIONS

Unless otherwise authorized by PETRONAS, the distribution of this PTS is confined to companies forming part of PETRONAS group and to Contractors nominated by them.

This PTS is primarily intended to be used for oil and/or gas transmission pipelines and related facilities. It is intended for use by Exploration and Production, Manufacturing, Chemicals or Supply/Marketing companies which require the use of linepipe.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this PTS the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this PTS 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 with the object of obtaining agreement to follow this PTS as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which 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 the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Defect (in NDT) - a discontinuity or group of discontinuities whose indication(s) do(es) not meet specified acceptance criteria.

Flaw/Discontinuity (in NDT) - an interruption, which may be either intentional or unintentional, in the physical structure or configuration of a pipe.

Indication (in NDT) - evidence of a discontinuity that requires interpretation to determine its significance.

Inspection release note - a document issued by the Principal to authorise shipment (applicable only if the Principal has been involved in monitoring production, inspection and/or documentation, see APPENDIX G.

Minimum operating temperature - the minimum temperature to which the pipeline or section of pipeline may be exposed during normal operational activities, including start-up and shut-down operations and controlled blowdown, but excluding abnormal situations such as pipeline ruptures.

Pipe bevel - the total weld preparation machined on the end of a pipe.

Plate or coil - the pipe material for welded pipe before forming into the shape of a pipe.

Purchaser - term used in API Spec 5LD which has the same meaning as Principal.

Radiological - term used in API Spec 5LD which has the same meaning as radiographic. The term radiographic is used in this PTS.

Seal weld - weld performed on the ends of lined pipe to seal the annulus between the CRA liner and carbon steel base pipe.

1.4 ABBREVIATIONS

CE	-	carbon equivalent
CLA	-	centre line average
CRA	-	corrosion resistant alloy
DN	-	diameter nominal
DWTT	-	drop weight tear test
ECT	-	eddy current testing
EMT	-	electromagnetic testing
FBH	-	flat bottomed hole
FCAW-MC	-	flux cored arc welding - metal cored
GMAW	-	gas metal arc welding
GTAW	-	gas tungsten arc welding
HAZ	-	heat affected zone
HV	-	Vickers hardness
ID	-	inside diameter
MFL	-	magnetic flux leakage
MPI	-	magnetic particle inspection
MT	-	magnetic particle testing
NDT	-	non-destructive testing
OD	-	outside diameter
PAW	-	plasma arc welding
Pcm	-	material cracking parameter
PQR	-	procedure qualification record
RDH	-	radially drilled hole
RT	-	radiographic testing
SAW	-	submerged-arc welding
SMAW	-	shielded metal arc welding
SMLS	-	seamless
UNS	-	universal numbering system
UT	-	ultrasonic testing
WPS	-	welding procedure specification

1.5 CROSS-REFERENCES

Where cross-references to other parts of this PTS are made, the referenced section number is shown in brackets. Other documents referenced in this PTS are listed in (Part III).

1.6 GUIDANCE FOR USE

The amendments to API Spec 5LD given in Part II are directly related to equivalent sections in API Spec 5LD. For clarity, the section and paragraph numbering of API Spec 5LD has been used as far as possible. Where clauses in API Spec 5LD are referenced within this PTS, it shall mean those clauses as amended by this PTS. Clauses in API Spec 5LD that are not amended by this PTS shall remain valid as written.

PART II AMENDMENTS/SUPPLEMENTS TO API SPEC 5LD

1 SCOPE

1.1 COVERAGE

Delete the third paragraph and replace with the following:

Grades of base metal covered by this specification are X52, X56, X60, and X70. Possible grades of the CRA layer include UNS Grades S31603, N08825, N06625 and any other alloy specified by the Principal.

Add new section:

1.4 CERTIFICATION

The Manufacturer shall furnish the Principal with a certificate of compliance in accordance with the requirements of Section 14.3.

The certificate shall comply with ISO 10474 type 3.1.B. See APPENDIX G.

Add new section:

1.5 QUALITY SYSTEM

The Manufacturer shall establish and maintain a quality assurance system in accordance with ISO 9001, or an approved equivalent, and shall furnish to the Principal a quality plan in accordance with APPENDIX I.

5 MANUFACTURING OF CLAD AND LINED STEEL PIPE

5.2 DESCRIPTION OF CLAD AND LINED STEEL PIPE

5.2.1 Clad Pipe

a) Seamless (SMLS).

Replace with the following:

Seamless clad pipe is produced by hot working composite material to form a tubular product without a welded seam.

b) Welded

Replace with the following:

See (Section 5.5) of this PTS.

5.2.2 Lined Pipe

Replace with the following:

The carbon steel base material for lined pipe shall be produced by the seamless process in accordance with (Section 5.2.1.a) and this PTS.

5.3 COLD SIZING AND COLD EXPANSION

Replace with the following:

SAW clad pipe shall be mechanically cold expanded. Expansion between 0.8% and 1.5% shall be applied.

Non-expanded SAW pipe shall not be supplied unless explicitly stated on the purchase order together with any supplementary test requirements.

5.4 HEAT TREATMENT

Replace this section with the following:

All carbon steel base material shall be fully killed and shall have a grain size of ASTM 7 or finer, as defined in ASTM E 112.

Seamless carbon steel base pipe shall be furnished in the hot formed, normalised, normalised and tempered or quenched and tempered condition. For hot formed pipe, the finishing temperature shall be greater than 780 °C. Pipe finished at a lower temperature than 780 °C shall be subjected to a further normalising heat treatment.

SAW carbon steel base pipe shall be furnished in the as-rolled, normalised, controlled rolled, controlled rolled plus accelerated cooled, or quenched and tempered condition.

The heat treating process shall be performed in accordance with a documented procedure. The manufacturer shall also establish and follow procedures for maintaining heat and/or lot identity.

For lined pipe, the carbon steel base material and CRA material may be heat treated individually before lining.

Add new section:

5.5 WELDED CLAD PIPE

Welded clad pipe is produced from clad plate or skelp.

During all stages of manufacture, contamination of the CRA layer with carbon steel shall be avoided. Direct contact of the CRA layer with carbon steel handling equipment (e.g. hooks) is prohibited.

a. Clad Steel Plate Inspection Prior to Pipe Manufacture

a.1 Visual Inspection

Visual inspection of the clad steel plate shall be performed over 100% of the clad surface. Visual inspection shall take place after any pickling and passivating of the clad surface. The examination shall be carried out in accordance with ASME Section V Article 9. A defect is unacceptable when any of the following limits are exceeded.

Defects:	Limit:
Scratches	Maximum depth = 0.5 mm
Pits	Maximum depth = 0.5 mm
Surface Roughness, Ra	Maximum Ra = 12.5 μm

The surface roughness shall be defined by the Centre Line Average (CLA) method.

a.2 Ultrasonic Inspection

Refer also to (Section 11).

Ultrasonic scanning of the clad steel plate shall be carried out over 100% of the clad surface to inspect for laminations and unbonded areas. This shall be carried out using a mechanised approach with automatic recording facilities, as specified in section 11.5.a using the reference standards in (Section 11.5.c) and applying the acceptance limits specified in (Section 11.5.d).

In addition, an automatic scanning device designed to disclose edge defects shall be employed to examine the edges of the plate, covering a width of 25 mm from the plate edge. The examination (equipment, reference reflector, acceptance/rejection levels) shall be in accordance with (Sections 11.5.a, 11.5.c and 11.5.d).

The plate thickness shall be checked by scanning along a grid pattern in such a way that at least 10% of the pipe surface is covered. The thickness of the clad layer shall be checked by electromagnetic (inductive or adhesive force) methods from the clad side or by other techniques agreed by the Principal, over a grid pattern in such a way that at least 25% of the surface is covered. The accuracy of the clad thickness measurement shall be better than 0.2 mm.

Requirements for the ultrasonic equipment and its calibration are referred to in (Section 11.5). The electromagnetic thickness measurements shall be carried out in accordance with ISO 2178 or ASTM B 499.

a.3 Dye Penetrant Inspection

All plate edges shall be dye penetrant inspected for cracks, laminations and disbonding in accordance with ASTM E 165.

No cracks, laminations or disbonding are allowed on the plate edges.

a.4 Repairs to Clad Layer

All indications found during inspection of the plate shall be documented by the Manufacturer and reported to the Principal.

All repairs shall be approved by the Principal and documented by the Manufacturer.

Surface defects on the cladding surface shall be removed by grinding and the remaining thickness (checked by ultrasonic examination) shall be within the limits given in (Section 13.2). The surface roughness of the repair shall conform to that specified in (Section 5.5.a.1).

The defective area shall be examined by dye penetrant inspection after grinding to ensure that all the defects have been removed.

NDT for acceptance of the clad plate may take place before pipe forming.

b. Process of Pipe Manufacture

b.1 Plate Forming Processes

The plate shall be formed into pipe at room temperature.

b.2 Welding Processes

All tack, longitudinal and girth welds shall be made in accordance with a qualified welding procedure (Section 14.6.b).

Tack welds shall be made using GMAW, gas shielded FCAW, or SMAW using low hydrogen electrodes. The diffusible hydrogen content of the resulting weld metal shall not exceed 10 ml/100 g of deposited metal.

The longitudinal and girth welds (if any) shall be full penetration welds using either of the following fusion welding processes: SAW, GTAW, GMAW, PAW and FCAW-MC (for backing metal of girth weld only).

The longitudinal seam shall be a double-sided butt weld. This shall be overlay welded on the inside such that the depth of the overlay is at least equal to the thickness of the cladding see (Section 7.12.a).

Welding parameters controlling the consistency of overlay welding of the internal bead shall be continuously recorded and records provided for subsequent verification.

Run-on and run-off tabs shall be used. The tabs shall be carefully removed by cutting.

For gas shielded welding processes, hydrogen additions in the shielding and/or backing gas are not permitted.

b.3 Filler Materials

b.3.a AISI 316L Stainless Steel (UNS: S31603) Clad Material

The longitudinal weld shall be overlay welded on the inside using either AISI 309 Mo or 309 MoL for the first layer and either 316L or 317L for subsequent layers. The molybdenum content of the filler material shall be sufficient to ensure the molybdenum content of the finished weld is equal to, or greater than, the molybdenum content of the clad material see (Section 6.1).

For girth welds welded from both sides, the requirements for the longitudinal weld shall apply. For girth welds welded from one side only, either AISI 309Mo or 309 MoL shall be used throughout.

b.3.b Incoloy 825 (UNS: N08825) Clad Material

The longitudinal weld shall be overlay welded on the inside using an Inconel 625 filler material.

For girth welds welded from both sides, the requirements for the longitudinal weld shall apply. For girth welds welded from one side only, Inconel 625 shall be used throughout.

In the selection of the welding parameters, specific care shall be taken to avoid hot cracking see also (Section 7.12.b).

b.3.c Inconel 625 (UNS: N06625) Clad Material

The longitudinal weld shall be overlay welded on the inside using an Inconel 625 filler material.

For girth welds welded from both sides, the requirements for the longitudinal weld shall apply. For girth welds welded from one side only, Inconel 625 shall be used throughout.

In the selection of the welding parameters, specific care shall be taken to avoid hot cracking (see also Section 7.12.b).

6 CHEMICAL PROPERTIES AND TESTS.

6.1 COMPOSITION

Replace this section (including Table 1) with the following:

The composition of the CRA layer and limitations on heat and product analysis shall be contained in the manufacturing procedure specification as detailed in (Section 14.5). The CRA layer shall conform to applicable ASTM standards such as ASTM A 240 UNS S31603 (for 316L), ASTM B 424 UNS N08825 (for Incoloy 825) and ASTM B 443 UNS N06625 (for Inconel 625), except that the molybdenum content of 316L shall not be less than 2.5 wt%. These compositions shall be confirmed by the pipe Manufacturer's product analysis reports.

6.2 HEAT ANALYSES OF THE CRA LAYER

Delete the second paragraph of this section.

6.3 PRODUCT ANALYSES OF BACKING STEEL, WELD & CRA

Replace this section with the following:

The CRA layer of one pipe per heat shall be analysed by the Manufacturer and shall be in accordance with the requirements of either (Section 6.3.a) or (Section 6.3.b) below.

a. Seamless Clad or Lined Pipe.

Samples for analyses shall be taken from finished pipe. In this instance, finished pipe shall mean pipe which has been formed and welded (if applicable) but not necessarily before trimming to final pipe lengths.

The composition of any analysis shall conform to the requirements of (Section 6.1).

b. Welded Clad or Lined Pipe.

Samples for analyses shall be taken from finished pipe. In this instance, finished pipe shall mean pipe which has been formed and welded (if applicable) but not necessarily before trimming to final pipe lengths.

The location of the samples shall be at least 90° from the weld of longitudinally welded pipe.

The composition of any analysis shall conform with the requirements of (Section 6.1).

6.6 BACKING MATERIAL

Replace this section with the following:

For each order, the Manufacturer shall propose a chemical composition for the pipe to be supplied. This composition shall be contained in the manufacturing procedure specification and, as determined by product analyses, shall be within the maximum allowable limits specified in Table 6.6, unless otherwise agreed by the Principal. The limitations on heat and product analyses are those agreed following acceptance of the manufacturing procedure specification (Section 14.5).

Table 6.6 Chemical requirements for heat analysis

Element	Maximum Permitted Alloy Content, wt%	Maximum Variation on agreed composition, wt%	Notes
C	0.16	0.03	-
Mn	1.70	0.30	-
Si	0.45	0.25	-
P	0.025	-	-
S	0.01	-	-
V	0.08	0.02	1
Nb	0.05	0.02	1
Ti	0.04	0.02	1
Cr	0.20	0.05	2
Mo	0.10	0.05	2
Ni	0.30	0.10	2
Cu	0.25	0.10	2
Al	0.06	-	3
N	0.012	-	3
B	0.0005	-	-
Ca	0.006	-	-
CE	0.39	-	4
Pcm	0.21	-	5

- Notes:
1. $V + Nb + Ti$ shall not exceed 0.15%.
 2. $Cr + Mo + Ni + Cu$ shall not exceed 0.6%.
 3. The total Al:N ratio shall not be less than 2:1.
 4. $CE = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$.
 5. $Pcm = C + Si/30 + (Mn + Cu + Cr)/20 + Ni/60 + Mo/15 + V/10 + 5B$.

6.6.a Chemical Analysis

1. Methods of Analysis

Methods and practices shall be carried out in accordance with ASTM A 751. Calibrations performed shall be traceable to national standards.

6.6.b Heat Analyses

The analysis of each heat of steel used in the manufacture of pipe specified on the purchase order shall conform to the requirements of (Section 6.6) as applicable.

6.6.c Product Analyses

Product analyses shall be carried out in accordance with Section 9.2 of API Spec 5L with the following amendments:

1. Sampling Methods

Add to this clause:

Samples may be taken using any of the methods indicated in API Spec 5L provided they are taken from finished pipe. In this instance, finished pipe shall be understood to mean pipe which has been formed and welded (if applicable) but not necessarily before trimming to final pipe lengths.

2. Product Analysis Variation

Replace this clause with the following:

The Manufacturer shall propose a nominal product analysis in the manufacturing specification. The range of acceptable variations in the product analysis is given in Table 6.6. This shall be applied to the chemical composition proposed by the Manufacturer in the manufacturing specification. The maximum variation on agreed composition is allowed provided that the final maximum alloys content given in Table 6.6 is not exceeded.

6.7.d Test Reports

The results of all specified chemical analyses shall be available to the Principal. The report of all chemical analyses required by this specification shall be provided in accordance with (Section 14.5).