TECHNICAL SPECIFICATION

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

DEP 31.40.20.32-Gen.

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DESIGN AND ENGINEERING PRACTICE

PREFACE

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PART I INTRODUCTION

1.1 SCOPE

This new DEP gives the minimum requirements for the purchase of seamless, centrifugally cast 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, first edition, January 1, 1993. Part II of this DEP gives amendments and supplements to clauses of API Spec 5LD which are considered necessary as a contribution to ensuring pipeline integrity in accordance with Shell Group requirements.

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

1.2 DISTRIBUTION, APPLICABILITY AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors and Manufactures/Suppliers nominated by them (i.e. the distribution code is "F" as defined in DEP 00.00.05.05-Gen.).

This DEP 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 DEP 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 DEP 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 DEP 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 F).

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 DEP.

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 DEP are made, the referenced section number is shown in brackets. Other documents referenced in this DEP 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 DEP, it shall mean those clauses as amended by this DEP. Clauses in API Spec 5LD that

are not amended by this DEP 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 12.3).

The certificate shall comply with ISO 10474 type 3.1.B. See (Appendix F).

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 G).

2. PROCESS OF MANUFACTURE AND MATERIAL

2.1 PROCESS OF MANUFACTURE

2.1.b Base Material for Clad Pipe

1. 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.

3. Welded

Replace with the following:

See (Section 2.4) of this DEP.

2.1.c Base Material for 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 2.1.b.1) and this DEP.

2.2 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.

2.3 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 and centrifugally cast 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:

2.4 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 8).

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 8.15.a) using the reference standards in (Section 8.15.c) and applying the acceptance limits specified in (Section 8.15.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 8.15.a, 8.15.c and 8.15.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 8.15). 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 7.3). The surface roughness of the repair shall conform to that specified in (Section 2.4.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 12.4.b).

Tack welds shall be made using GMAW, gas shielded FCAW, or SMAW using low hydrogen electrodes. The diffusable 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 5.4.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 3.1).

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 5.4.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 5.4.b).

3. CHEMICAL PROPERTIES AND TESTS

3.1 COMPOSITION

Replace this section (including Table 3.1) 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 12.3). 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.

3.2 HEAT ANALYSES OF THE CRA LAYER

Delete the second paragraph of this section.

3.3 PRODUCT ANALYSES OF THE CRA LAYER

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 3.3.a) or (Section 3.3.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 with the requirements of (Section 3.1).

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 3.1).

3.7 BASE 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 3.7, unless otherwise agreed by the Principal. The limitations on heat and product analyses are those agreed following acceptance of the manufacturing procedure specification (Section 12.3).

Table 3.7 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.

3.7.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.

3.7.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 3.7), as applicable.

3.7.c Product Analyses

Product analyses shall be carried out in accordance with Section 3.4 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 3.7. 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 alloy content given in Table 3.7 is not exceeded.

3.7.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 12.3).

4. MECHANICAL PROPERTIES AND TESTS

4.1 MECHANICAL PROPERTIES

Delete the first paragraph and replace with the following (Table 4.1 of API Spec 5L remains):

All mechanical tests shall be performed on specimens taken from base pipe (unless otherwise stated) which has been subjected to all of the cold and hot working, and all of the heat treatment procedures (including any heat treating required to install liners) which are performed on the finished product.

For all pipes, the ratio of body yield strength to tensile strength shall not exceed 0.90 when tested using flattened bar tensile specimens. For round bar and non-flattened rectangular specimens, the ratio of yield strength to tensile strength shall not exceed 0.93.

The measured yield strength shall not exceed the minimum values indicated in column 2 of Table 4.1 of API Spec 5L by more than 150 MPa.

The required minimum tensile elongation shall be determined according to the formula given in footnote 1 of Table 4.1 but shall not be less than 20%.

Samples removed for the determination of tensile, toughness or microstructural properties shall be prepared by machining. If thermal cutting is used to remove pipe coupons from which test specimens are prepared, the full extent of the heat affected region shall be removed during machining of the specimens.

4.2 TENSILE TESTS - GENERAL

Replace this section with the following :

The testing procedure shall be in accordance with ASTM A 370. Tensile test specimen orientation and dimensions shall be taken in accordance with API Spec 5L, Figure 4.1 and Figure 4.2 for longitudinal seam welds.

4.3 TESTING FREQUENCY

Replace this section with the following:

Both longitudinal and transverse tensile tests shall be performed on samples taken from two pipes per heat. For heats of less than 100 tonnes, tests on only one pipe shall be required.

4.5 TRANSVERSE TENSILE TESTS

Replace this section with the following:

Transverse tensile properties shall be determined from flattened rectangular specimens, without the CRA layer. The ring expansion method shall only be applied after specific approval has been obtained from the Principal.

4.6 WELD TENSILE TESTS

Add to this section:

Weld tensile specimens shall be taken from the same part of the pipe used for preparing parent metal tensile specimens. The weld reinforcements shall be removed before tensile testing.

4.9 FLATTENING TESTS - ELECTRIC WELD BASE MATERIAL

Delete this section.

4.10 ACCEPTANCE CRITERIA

Delete this section.

4.11 RETESTS

Delete this section.

4.14 GUIDED BEND TEST- CLAD PIPE ONLY

Replace this section with the following:

Guided bend tests shall be performed on welded pipe in accordance with API Spec 5L.

One side bend test on the base material including the cladding layer and one transverse face and one transverse root bend shall be carried out on each type of weld (if applicable) in accordance with ASTM A 370.

The minimum bending angle shall be 150° with a bend radius of 1.5t, where t is the plate thickness (including cladding).

For acceptance, specimens shall not show any disbonding nor any open flaws exceeding 1.6 mm in length.

4.16 WELD DUCTILITY TEST FOR ELECTRIC-WELDED PIPE

Delete this section.

4.17 RETESTS

Delete this section.

4.18 CENTRIFUGALLY CAST HOMOGENEITY TEST

Replace this section with the following:

The chemical composition of the CRA layer and base material shall be determined using a spectrographic technique to be agreed by the Principal. The CRA analyses shall be taken from four equidistant locations around the pipe and at a depth of 1mm from the inner surface. The base material analyses shall be taken from four equidistant locations around the pipe at a depth of 1 mm from the outer surface. The composition of the CRA layer shall be in accordance with the requirements of (Section 3.1) and the base material in accordance with (Table 3.7). This test shall be carried out on a ring cut from one end of each selected pipe.

Add new section:

4.19 HARDNESS TESTS

Hardness testing shall be performed in accordance with (Section 13.4) to determine the hardness of the carbon steel base material.

Add new section:

4.20 FRACTURE TOUGHNESS TESTS

4.20.a Charpy V-Notch Test

For all pipe, Charpy V-notch tests shall be performed in accordance with (Appendix E, Section SR5) on each test ring taken for tensile testing.

If stress relieving is required for field welds, Charpy testing shall also be performed in the simulated stress relieved condition. The Principal shall inform the Manufacturer at the time of enquiry/order of the need for testing in the stress relieved condition.

For gas transmission pipelines with a diameter of DN 400 (16 inch) or greater, drop weight tear tests shall be carried out on one pipe for every heat of steel, in accordance with the requirements in (Appendix E, Section SR6).

5. SPECIAL TESTS

5.1 FERRITE/AUSTENITE RATIO FOR DUPLEX STAINLESS STEEL

Delete this section.

5.2 INTERGRANULAR CORROSION TEST (STRAUSS TEST)

Delete this section.

5.3 TEST FOR BONDING

a. Clad Steel Pipe

Replace this section with the following:

Three transverse face bend tests shall be made on material remote from the weld (if applicable) in accordance with ASTM A 264, to check bond quality.

In addition, three shear tests shall be made on material remote from the weld in accordance with ASTM A 264 except that the minimum shear strength shall be 250 MPa instead of 140 MPa.

Add new section:

5.4 METALLOGRAPHIC EXAMINATION

5.4.a Microstructure

Three microsection specimens shall be taken from the longitudinal and circumferential (if applicable) weld samples. The exact locations shall be determined by the Principal. These samples shall be cut to expose weld cross-sections, polished and etched, after which the welds shall be macroscopically and microscopically examined to check the following:

Feature	Acceptance Criteria
weld fusion	complete
weld undercut	0.5 mm maximum
radial offset of plate edges at the longitudinal weld	(See section 9.2.b)
continuity of corrosion resistant alloy across weld	100% continuous
thickness of cladding	3.0 mm (+1.00, -0.00)
minimum thickness of overlay	3.0 mm (+1.00, -0.00)
presence of hot cracks	none allowed
presence of sigma phase	none allowed
ferrite content of austenitic weld deposit for AISI 316 stainless steel (point counting or magnetic methods)	5-13%

5.4.b Chemical Analysis of Weld Overlay

A check of the chemical analysis of the weld overlay shall be made on one of the specimens from (Section 5.4.a) or on another specimen specially prepared for this purpose.

The analysis shall be done by energy dispersive X-ray spectroscopy at a point located in the middle of the overlay bead, 1 mm below the surface and shall conform with (Section 3.1). If overlay welding is done with two beads, each bead shall be analysed separately.

The elements to be analysed shall include Mn, Cr, Ni, Mo and Fe. The values measured shall be consistent with a dilution of the filler metal composition by less than 25%. In the case of Inconel 625 overlay, the iron content shall not exceed 25%.

6. HYDROSTATIC TESTS

6.1 INSPECTION HYDROSTATIC TEST

Replace this section with the following:

All clad pipe shall be hydrostatically tested after cladding, double jointing (if applicable) and final heat treatment but before all non-destructive testing described in (Section 8). The components of lined pipe (i.e. the base material and CRA pipe) may be non-destructively tested before hydrostatic testing of the lined pipe, if agreed by the Principal.

Only fresh water with a chloride ion content of less than 200 mg/kg shall be used for the test.

Each length of pipe shall withstand, without leakage, a hydrostatic test to at least the pressure specified in (Section 6.3). Hydrostatic testing shall be performed after cold expansion (where applicable).

After hydrostatic testing, the pipes shall be dried and kept dry by the use of end caps.

6.2 VERIFICATION OF TEST

Replace this section with the following:

The hydrostatic test shall be verified in accordance with API Spec 5L, Section 5.2.

6.3 TEST PRESSURES

Replace this section with the following:

The test pressure for all types and sizes of pipe shall be such that the hoop stress, calculated on the basis of the minimum specified wall thickness of the base material and including stresses from end loading, is at least 95% of the specified minimum yield strength.

If applied, the end compensation factor as determined by the formula given in API Spec 5L, Appendix E, Section SR14 shall be used.

Each pipe shall be hydrostatically tested at room temperature maintaining the calculated test pressure for at least 15 seconds.

The test pressure and test method shall be approved by the Principal prior to testing.

6.4 SUPPLEMENTARY HYDROSTATIC TESTS

Delete this section.

7. DIMENSIONS, WEIGHTS AND LENGTHS

7.1 DIMENSIONS AND WEIGHTS

Add new clause:

All dimensional tolerance inspection shall be carried out with the pipe in its final condition.

7.2 DIAMETER

Replace this section with the following:

The diameter of the pipe shall be within the tolerances specified in Table 7.1, as amended below.

Table 7.1 TOLERANCES ON DIMENSIONS AND WEIGHTS

Replace the appropriate sections of this Table with the following:

Pipe Body

The outside diameter of the pipe body, as determined by taping the circumference, shall not deviate by more than ± 3 mm from the value given in metric Table 6.2 of API Spec 5L.

Pipe Ends

For a length of 100 mm from each pipe end, the average internal diameter shall not deviate from the nominal internal diameter by more than ± 1.5 mm for welded pipe or ± 2.0 mm for seamless pipe.

The nominal internal diameter is defined as the outside diameter OD (given in metric Table 6.2 of API Spec 5L), minus twice the nominal wall thickness of the base material and CRA layer combined.

The internal diameter shall be measured using an internal gauge or a measuring tape inside the pipe. The method and equipment used shall be approved by the Principal. For pipe of DN 200 (8 inch OD) and smaller, the internal diameter may be calculated by measuring the outside diameter with a circumference tape and subtracting twice the actual wall thickness from this value.

Out-of-Roundness

The pipe shall be checked for out-of-roundness using an internal ring gauge of diameter 5.0 mm less than the nominal internal diameter. The gauge shall pass freely into each end of the pipe, for a distance of at least 100 mm, when held normal to the pipe axis.

The out-of-roundness of the pipe body shall be determined by measuring the maximum and minimum external diameter at a pipe cross-section.

The maximum allowable out-of-roundness is given by:

$$OD_{max} - OD_{min} \leq 3 \text{ mm}$$

The pipe shall be measured for out-of-roundness at three equidistant locations along the pipe body. The same three positions along the length shall be checked for non-circularity at the position of the longitudinal weld (if applicable).

7.3 WALL THICKNESS

Replace this section with the following:

For all sizes of welded pipe, the carbon steel base material wall thickness at any place in the pipe, measured during final inspection, shall not deviate from the nominal wall thickness by more than the tolerances specified in the following table:

Nominal Wall Thickness, t (mm)	Minus Tolerance	Plus Tolerance
$t \leq 7$	0.35 mm	10%
$7 < t \leq 10$	5%	10%
$t > 10$	0.50 mm	10%

For all sizes of seamless pipe, the wall thicknesses at any point shall not deviate from the nominal thickness by more than +15% or -10%.

The CRA layer shall have a thickness of 3.0 mm (+1.00, -0.00)

7.5 LENGTH

Replace this section with the following:

The pipes shall be supplied in lengths between 11.6 and 12.8 m.

Jointers (if used) shall be supplied in lengths between 5.6 and 6.6 m.

7.6 STRAIGHTNESS

Replace this section with the following:

All pipe shall be checked for straightness using a taut string or wire from end to end along the side of the pipe. The maximum straightness deviation shall be 1.5 mm/m (measured in any 1 m length of the pipe) and 12 mm total over a full length of pipe.

7.7 JOINTERS

Replace this section with the following:

Pipes may be furnished by welding together jointers provided that each pipe length does not contain more than one girth weld and that the longitudinal welds (if applicable) are staggered by 45° - 90°. Girth welding shall be carried out in accordance with a procedure approved by the Principal. No expansion shall be carried out after the circumferential weld has been completed.

7.8 PIPE ENDS

Replace this section with the following:

Clad pipe shall be supplied with pipe ends cut perpendicular to the pipe axis. The maximum deviation from the perpendicular shall be 0.5% of the nominal outside diameter, with a maximum of 1.5 mm.

The ends of all lined pipe shall be seal-welded. The pipe ends shall be prepared and welded in accordance with a procedure approved by the Principal.

8. NON-DESTRUCTIVE INSPECTION

8.1 INSPECTION METHODS FOR WELDED CLAD PIPE

Replace this section with the following:

GENERAL

The Manufacturer shall demonstrate to the Principal prior to the start of pipe production that the NDT techniques and procedures to be used are capable of identifying all surface and sub-surface defects referred to in this DEP.

Measuring equipment for inspection and testing shall be selected such that it has a resolution and accuracy at least five times finer than the tolerance of the parameter being measured. Similarly, standards against which a piece of equipment is calibrated shall be at least five times as accurate as the equipment being calibrated.

Only measuring equipment which can be demonstrated to have been previously calibrated satisfactorily and still be within its documented calibration period (interval) shall be used for inspection and testing.

All NDT shall be performed by an inspector qualified to ISO 9712 level II or equivalent in the relevant technique: equivalence must be documented and accepted by the Principal. For ultrasonic testing, at least one ISO 9712 level III or equivalent qualified inspector shall be available to the mill (on call) for endorsement of relevant NDT procedures and verification of the quality of NDT reports. A level II inspector is required for shift supervision, manual weld inspection and calibration of both manual and automated systems.

An ISO 9712 level I inspector is acceptable for all other NDT methods. An ISO 9712 level II inspector is acceptable for supervision of all other NDT methods.

All NDT shall be performed in accordance with written procedures which shall have the prior approval of the Principal.

NDT for acceptance of the pipe (final inspection) shall take place after all heat treating and expansion operations and, for welded pipe, after hydrostatic testing of the pipe. It may, however, take place before cropping, bevelling and end sizing.

8.1.a Radiographic Testing

For each length of welded pipe, the circumferential girth welds (if any) and the ultimate 200 mm at both ends of the longitudinal weld seam shall be 100% radiographed in accordance with ASME Section V, Article 2 and (Section 8.4).

8.1.b Ultrasonic Testing

For each length of pipe, the longitudinal weld seam and circumferential girth welds (if any) shall be inspected over their entire length using the ultrasonic equipment specified in (Section 8.15.a), using the reference standards in (Section 8.15.c) and applying the acceptance limits specified in (Section 8.15.d). End portions of the weld seam that are not tested automatically shall be tested manually.

Inspection for both longitudinal and transverse defects, as well as for chevron cracks, shall be carried out simultaneously.

The pipe ends shall be tested for laminations and disbonding from the clad side using the probes specified in (Section 8.15.a) and applying the reference standards in (Section 8.15.c) and the acceptance limits specified in (Section 8.15.d).

When the pipe is in its final condition, an area of 25 mm width adjacent to the weld seam shall be inspected over its entire length for disbonding and laminations with an automatic ultrasonic scanning device, in accordance with (Section 8.15). There shall be no laminations or disbonding of the clad layer in this region.

8.1.c Dye Penetrant Testing

When the pipe is in its final condition, and after grinding off the internal weld reinforcement at the pipe ends, the longitudinal weld shall be dye penetrant inspected internally over a length of 1.5 times the outside diameter at each pipe end, according to ASTM E 165.

If any cracks are found, the pipe end must be cut off 25 mm beyond the end of the crack and the longitudinal weld at the new pipe end ground off and dye penetrant inspected as described above.

8.2 INSPECTION METHODS FOR SEAMLESS AND CENTRIFUGALLY CAST CLAD PIPE

Replace this section with the following:

8.2.a Ultrasonic Testing

When the pipe is in its final condition, it shall be inspected over its entire length for disbonding and laminations using an automatic ultrasonic scanning device in accordance with (Section 8.15.a), using the reference reflectors in (Section 8.15.c) and applying the acceptance limits specified in (Section 8.15.d). Pipe ends that are not tested automatically shall be tested manually. The pipe ends shall also be tested from the clad side for laminations and disbonding.

Inspection for both longitudinal and transverse defects shall be carried out simultaneously with an automatic ultrasonic scanning device in accordance with (Section 8.15.c). Reference reflectors and acceptance criteria are defined in (Section 8.15.c and 8.15.d).

If feasible, ultrasonic inspection shall also be used to determine the wall thickness of the base material and of the CRA layer. The coverage shall be 25% of the pipe outside area. If not, then electromagnetic (inductive or adhesive force) methods shall be applied from the inside to measure the thickness of the clad layer at a location every 250 mm along the length of the pipe. The accuracy of the clad thickness measurement shall be better than 0.2 mm.

8.3 INSPECTION METHODS FOR LINED PIPE

Replace this section with the following:

8.3.a Prior to Pipe Assembly

8.3.a.1 Radiographic Testing

Prior to assembly of the CRA liner and the carbon steel base pipe, the CRA liner weld seam, if any, shall be 100% radiographically inspected in accordance with ASME V, Article 2 and (Section 8.4).

8.3.a.2 Ultrasonic Testing

Prior to assembly of the CRA liner and the carbon steel base pipe, the thickness of the CRA liner shall be inspected and be in accordance with (Section 7.3). This inspection may be carried out on the stainless steel plate or skelp prior to fabrication of the liner.

Ultrasonic lamination inspection of each seamless pipe body shall be performed using a helical pattern with at least 25% scanning coverage of the pipe surface. Ultrasonic thickness testing of the pipe body and ends shall be performed by scanning along a helical or straight pattern in such a way that at least 10% of the pipe surface is covered. The body and ends of all seamless pipe shall be 100% ultrasonically inspected for inside and outside surface defects as well as transverse and longitudinal embedded defects.

The weld seam (if applicable) of any CRA liners shall be 100% inspected for transverse, longitudinal and inclined embedded defects. Equipment, reference reflectors and acceptance criteria are defined in (Section 8.15).

8.3.b After Pipe Assembly

8.3.b.1 Ultrasonic Testing

When the pipe is in its final condition, it shall be ultrasonically inspected over its entire length to determine the wall thickness of the base material and the thickness and continuity of the CRA liner. If it is not possible to determine the thickness of the CRA liner using ultrasonic techniques, then electromagnetic (inductive or adhesive force) methods or other techniques may be used from the inside of the pipe, with the prior consent of the Principal. A grid pattern covering at least 25% of the surface shall be used to measure the thickness of the CRA liner. The accuracy of the CRA liner thickness measurement shall be better than 0.2 mm.

Requirements for the ultrasonic equipment and its calibration are referred to in (Section 8.15). The electromagnetic thickness measurements shall be carried out in accordance with ISO 2178 and/or ASTM B 499.

8.3.b.2 Dye Penetrant Testing

When the pipe is in its final condition, and after grinding off the internal weld reinforcement at the pipe ends, the end seal weld shall be dye penetrant inspected according to ASTM E 165.

Surface breaking flaws shall be removed by grinding and the remaining thickness (checked by ultrasonic examination) shall be within the limits given in (Section 7.3). In all cases where grinding repairs are made as a result of flaws being disclosed by NDT, the part of the weld containing such repairs shall be subjected to additional dye penetrant testing after the grinding operation.

8.4 RADIOLOGICAL INSPECTION

a). Equipment

Replace this section with the following:

The radiographic examination shall be executed with X-ray equipment using the film type indicated below:

- Speed : slow
- Contrast : very high
- Grain : very fine
- Examples : Kodak Industrex M, Kodak Industrex TMX, Kodak Industrex T, Agfa D2, Agfa D4, Fuji 50.

The Manufacturer shall record on a review form accompanying the radiograph or within the mill computer system, the interpretation of each radiograph and disposition of the pipe inspected.

For pipe wall thicknesses in excess of 20 mm, RT is not allowed and acceptance shall be based on UT, in accordance with the requirements of (Section 8.15).

8.5 FLUOROSCOPIC OPERATOR QUALIFICATION

Delete this section.

8.6 OPERATOR CERTIFICATION

Delete this section.

8.7 REFERENCE STANDARDS

Replace this section with the following:

The penetrameter used shall be of the wire type in accordance with ISO 1027. The selection of penetrameter wire diameters shall be based on a sensitivity of 2% of weld metal thickness.

8.10 PROCEDURE FOR EVALUATING IN-MOTION OPERATION OF THE FLUOROSCOPE

Delete this section.

8.11 ACCEPTANCE LIMITS

Add to the existing section:

Films shall be judged in accordance with ASME VIII, Division 1, Paragraph UW 51 with the following additions:

- continuous or semi-continuous undercut on the inside or outside of the pipe may not exceed a depth of 0.5 mm.
- any sharp or crack-like indication is unacceptable, regardless of depth.

8.14 WELD REPAIR

Replace this section with the following:

If any weld defects are detected by radiographic inspection, they shall be rejected and treated in accordance with (Section 9.5).

Add new section:

8.15 ULTRASONIC AND ELECTROMAGNETIC INSPECTION

GENERAL

The Manufacturer shall demonstrate to the Principal that the selected ultrasonic techniques are capable of detecting the following defects (in accordance with the requirements of this DEP):

- disbonding between CRA and base metal;
- longitudinal and transverse defects in seamless pipe;
- longitudinal and transverse defects in the longitudinal and circumferential (if applicable) seam welds of welded clad pipe.

8.15.a Ultrasonic Equipment

The automatic ultrasonic equipment shall incorporate:

1. A device which monitors the effectiveness of the coupling.

   In the case where a zero degrees compression wave probe is used to monitor coupling, or where a through transmission technique is used for seamless or centrifugally cast pipe, loss of coupling exists when the sensitivity (echo height) decreases by more than 10 dB relative to the static calibration.

   Where a through transmission technique through the weld seam is used for SAW linepipe, loss of coupling exists when the signal drops below the electronic noise plus 10 dB, at the position of the through transmission signal.

   A clear acoustic warning system and an automatic paint spray system (or equivalent) shall be activated when loss of coupling occurs.

2. An automatic paint-spraying device, or equivalent system, which is activated when the received ultrasonic echo exceeds the preset acceptance limit. This alarm shall operate without any interference from the ultrasonic operator and shall be applied within 25 mm advancement past the detected defect. The reset time of the alarm system to be available for detection following detection of a defect, shall be shorter than the time for 25 mm advancement in the scanning direction.

3. An automatic weld tracking system for correct positioning of the crystals/probes with respect to the weld centre of all welded pipe.

If ultrasonic angle beam shear wave inspection is feasible, the entrance angles of shear wave probes shall be as follows:

Seamless/Centrifugally Cast pipe	: 45 (40 - 48) degrees
SAW pipe longitudinal defect detection	: 50 - 70 degrees
SAW pipe transverse defect detection	: 45 (40 - 48) degrees (on weld bead)
	: 50 - 70 degrees (X or K transmission)

NOTE: Part of the completed longitudinal and girth weld will be austenitic and may be relatively coarse grained in comparison with the fine-grained ferritic base steel. Consequently, conventional ultrasonic examination using angle beam shear waves may be significantly hampered, exhibiting a very poor signal to noise ratio (less than 10 dB at acceptance limit according to (Section 8.15.3 and 8.15.4)). In this case, the use of angle beam compression wave and creep wave ultrasonic examination should be considered.

The transducer arrangement shall be such that the sound intensity in both the longitudinal and circumferential directions does not decrease by more than 3 dB at any point in the pipe wall, referred to the maximum sound intensity adjusted in the static calibration.

Lamination testing may be performed in pulse echo or transmission mode and wall thickness determination in pulse echo mode only. The probe(s) used for lamination/wall thickness testing shall satisfy the following requirements:

- Twin crystal probes : The focal length should be approximately 50% of the wall thickness
- Single crystal probes in pulse echo mode : The near surface resolution shall be better than 25% of the wall thickness, measured at the primary reference sensitivity level.

Disbonding detection between the CRA and base steel may be performed in the pulse echo mode from either steel or clad side or in the transmission mode. The probes used for disbonding detection in pulse echo shall satisfy the following requirements:

- Twin crystal probes : The focal length shall be equal to the position of the clad to steel interface
- Single crystal probes in pulse echo mode : The near surface resolution shall be better than 25% of the wall thickness when testing from the carbon steel side or 50% of the clad layer thickness when testing from the clad side, all measurements being made at the primary reference sensitivity level.

The equipment shall be checked with an applicable reference standard as described in (Appendix D) at least every four hours and at the beginning and end of a batch, in order to demonstrate the effectiveness of the inspection procedures and show that the equipment is functioning correctly.

If discrepancies of more than 3 dB occur, then all pipes inspected since the previous check shall be reinspected. Proper functioning of the UT equipment and the linearity of the electronic instrumentation shall be checked at least once every six months or if a change is made to the equipment.

From each pipe under test, an automatic "on-line" record shall be made without operator intervention. For every pipe, a summary record shall be made showing pipe identification number, time and examination results, including re-examinations.

If parts of the ultimate pipe ends are not covered by an automatic UT system, manual UT shall be carried out using approved procedures for manual UT examination based on the requirements given above.

The complete circumference of seamless pipe ends shall be tested manually over the length of the untested area plus 25 mm overlap of the automatically tested area.

8.15.b Electromagnetic Equipment

EMT methods such as eddy current testing (ECT) and magnetic flux leakage (MFL) testing may be applied for surface defect and flaw detection in seamless pipe.

Inspection of the outer layer (carbon steel) shall be carried out by MFL from the outer surface in accordance with ASTM E 570, while the CRA layer shall be inspected by ECT from the clad side. Testing shall be performed by automatic equipment over the entire surface of the pipe.

If parts of the ultimate pipe ends are not covered by an automatic EMT system, then manual UT shall be carried out using approved procedures for manual ultrasonic examination based on the requirements given above. The complete circumference of the pipe ends shall be tested by manual UT over the length of the untested area plus 25 mm overlap of the automatically tested area.

8.15.c NDT Reference Standards

The reference calibration standard shall have the same nominal diameter and thickness as the product being inspected and shall be of sufficient length to permit calibration of ultrasonic inspection equipment at the speed to be used in production. The reference standard shall also be of the same material type and have the same surface finish and heat

treatment as the product to be inspected. It shall be free from discontinuities or other conditions producing indications that may interfere with detection of the reference reflectors. The reference standard shall contain notches and radially drilled holes (3.2 mm) as shown in (Appendix D), and/or flat bottomed holes. The type and location of the notches and drilled holes in the reference standard for welded pipe, shall be in accordance with (Appendix D).

The Manufacturer may use a type of reference reflector not specified above, provided he can demonstrate to the Principal that the examination is at least as sensitive as prescribed in this specification. In such cases, the Manufacturer shall obtain approval from the Principal.

The primary reference sensitivity level shall be adjusted on the following reference reflectors:

Type of Examination	Type of Pipe	
	SMLS	SAW
Lamination detection	FBH 6.3 mm	FBH 6.3 mm
Disbonding detection	FBH 6.3 mm	FBH 6.3 mm
Surface defect detection	Notch N5	
Defect detection body and pipe ends	Notch N5	
Defect detection weld		RDH 3.2 mm
Defect detection plate end axial defect		Notch N5

All sensitivity adjustments shall be carried out dynamically.

Flat bottomed holes for lamination detection shall be applied at the midwall position. Flat bottomed holes for disbonding detection shall be applied at the cladding layer/parent metal interface position.

8.15.d Acceptance Limits

For all reference reflectors except for RDH 3.2 mm, the acceptance limit signal shall be equal to the primary reference sensitivity level, i.e. equal to the height of the signal produced by the reference reflector. For the RDH 3.2 mm reference reflector, the acceptance limit signal shall be 10 dB below the primary reference sensitivity level.

For all examination types, indications exceeding the acceptance limit signal are unacceptable.

For lamination detection in plate, seamless pipe body and pipe ends, the acceptance limits shall be based on the lamination size and frequency and be in accordance with the classification of SEL 072, as described below:

LOCATION	SEL 072 Lamination Acceptance Levels
Plate Body	Table 1. Class 3
Plate/Pipe Edges	Table 2. Class 1
Seamless Pipe Body	Table 1. Class 3

For the detection of disbonding in clad plate, welded pipe, seamless/centrifugally cast pipe bodies and pipe ends, the acceptance limits shall be based on the frequency of disbonding occurrences and be in accordance with the Table below:

LOCATION	Acceptable Number of Disbonding Indications
For longitudinally welded pipe:	
Plate/Pipe Body: locally per area of 1 m x 1 m average per plate per m^2	10 indications not exceeding 30 mm^2 each 5 indications not exceeding 30 mm^2 each
Plate/Pipe Edges	none
For seamless/centrifugally cast pipe:	
Pipe Body locally per area of 1 m x 1 m average per pipe per m^2	10 indications not exceeding 30 mm^2each 5 indications not exceeding 30 mm^2 each
Pipe Ends	none

Add new section:

8.16 MAGNETIC PARTICLE INSPECTION

8.16.a Equipment

The equipment used for MT shall produce a magnetic field, transverse to the defect orientation, and of sufficient intensity to indicate defects in the external surfaces of the pipe.

MT shall be performed in accordance with the requirements of ASTM E 709.

The surface to be examined and all adjacent areas within 25 mm shall be dry and free of all dirt, grease, lint, scale, welding flux and spatter, oil or other extraneous matter that could interfere with the inspection.

8.16.b Acceptance Limits

Acceptance shall be in accordance with API Spec 5L, Section 9.21 and the following:

The pipe weld, body/ends and the bevelled surface shall be free from flaws visible to the naked eye, such as laps, cracks or laminations.

9. WORKMANSHIP, VISUAL INSPECTION AND REPAIR OF DEFECTS

9.1 PURCHASER INSPECTION

Replace this section with the following:

The requirements of (Appendix F) shall apply.

9.2 WORKMANSHIP

a. Dents

Replace the third sentence of this section with the following:

All cold formed dents with a sharp bottom gouge and all sharp gouges (without dents) deeper than 1.0 mm shall be considered defects requiring rectification or rejection.

b. Offset of Plate Edges

Replace this section with the following:

The radial offset of plate edges (misalignment) for SAW pipe with a nominal wall thickness of 10.0 mm or less shall be no more than 1.5 mm. For pipe with a nominal wall thickness greater than 10.0 mm, the maximum allowable radial offset shall be 1.6 mm.

d. Height of Outside and Inside Weld Beads.

Replace this section with the following:

The maximum height of any weld bead shall be 3.2 mm for all wall thicknesses.

The longitudinal weld reinforcement on the inside of the pipe shall be ground back to the thickness of the cladding over a distance of 100 mm from the pipe ends. If the external weld reinforcement also protrudes, it shall also be ground back over the same distance. The pipe ends shall be prepared as described above before hydrostatic testing is carried out.

Weld beads higher than permitted by the requirements of this clause shall be ground to acceptable limits at the option of the Manufacturer.

At pipe ends and other areas which are radiographed, the reinforcement of both the inside and outside bead shall allow compliance with the radiographic sensitivity requirements of (Section 8.4).

f. Grinding

Replace this section with the following:

Defects and flaws may be removed by grinding provided the remaining wall thickness is not less than the nominal wall thickness less the negative tolerance. For an area up to 2500 mm², a remaining thickness of 95% of the specified wall thickness less the negative tolerance is acceptable provided the edges of the defect have been ground smooth and that all such areas are spaced at a minimum distance of twice the pipe diameter. The surface roughness of the repair shall conform to that specified in (Section 2.4.a.1).

In all cases where grinding repairs are made as a result of defects or flaws being disclosed by NDT, the part of the pipe containing such repairs shall be subjected to additional NDT using the same technique, and to MT, after the grinding operation.

g. CRA Layer

Replace this section with the following:

The CRA shall be inspected for continuity as described in (Sections 8.1, 8.2 and 8.3).

9.3 VISUAL INSPECTION

Replace this section with the following:

The full body and welds (if applicable) of every pipe shall be examined internally and externally for surface defects. For internal examination of pipe DN 600 (24 inch OD) and

larger, the inspector shall pass through the bore of the pipe. Sufficient illumination (more than 500 lux) shall be provided to enable proper inspection. The examination shall be carried out in accordance with ASME V, Article 9.

9.4 DEFECTS

e. Disbonding

Replace this section with the following:

Any detected disbonding between the base metal and CRA layer of clad pipe shall be in accordance with (Section 8.15.d).

f. Other Defects

Add the following to this section:

Local Irregularities of SAW Pipe Welds

The ends of each SAW pipe and two positions along its length shall be checked for out-of-roundness at the position of the longitudinal weld. Local irregularities shall be measured with a template with a minimum chord length of 75% of the pipe diameter, which for pipes DN 400 and above shall be not less than 300 mm. The template profile shall have a radius equal to the nominal radius of the pipe outer or inner circumference for measurement of the outer or inner surface respectively. The nominal inner radius shall be taken as the nominal outer radius minus the nominal wall thickness.

The template gauging surface shall have a cut-out to accommodate the weld bead of the pipe. The cut-out shall be at the centre of the gauging surface and shall have a width of less than 5 mm greater than the weld bead width. Any local irregularity shall be measured by a calibrated taper gauge inserted in any gap between the template and the pipe surface. The local irregularity shall not exceed 1.6 mm.

g. Disposition

Replace clause 1 with the following:

1. Defects may be removed by grinding in accordance with (Section 9.2.f).

9.5 REPAIR OF DEFECTS

a. Base Metal

Replace this section with the following:

The repair of any defects in the base metal away from the weld zone shall be carried out in accordance with (Section 9.2.f). The weld zone shall be defined as the region within 13 mm on either side of each fusion line.

There shall not be any repair welding on seamless pipe or on the base metal of welded pipe.

c. Weld Seam

Delete existing clause and replace with the following:

There shall not be any repairs on the longitudinal weld seam of SAW pipe within 200 mm of the pipe ends.

The nature of any NDT indication shall be ascertained before any repair is performed. Where necessary, complementary ultrasonic and radiographic inspections shall be carried out to characterise the defect. Repair welding to rectify pipe welds containing cracks is not permitted.

Repairs to the weld seam shall be limited to three per pipe. No repair weld shall exceed 5% of the total weld length on each pipe.

Weld repairs shall not be carried out after cold expansion or hydrostatic testing of a pipe.

9.6 PROCEDURE FOR REPAIR OF WELD SEAMS OF SUBMERGED ARC WELDED PIPE

Add new clause:

9.6.d

The pipe weld seam shall be re-inspected (over its full length) in accordance with (Section 8.1).

9.7 PROCEDURE FOR REPAIR OF WELD SEAMS OF ELECTRIC WELD AND INDUCTION WELDED PIPE

Delete this section.

10. MARKING AND SURFACE TREATMENT

10.1 MARKING - GENERAL

Add to this section:

In addition to the marking specified on the pipes, the Manufacturer shall supply the Principal with lists of pipe produced stating pipe identification numbers, heat numbers, dimensions, weights of lots of pipe or individual pipe lengths, purchase order numbers, type of certificates issued and any further items that may be indicated on the purchase order.

For pipes DN 100 and larger, stencil markings required by this DEP shall be executed in white block capitals of minimum height 19 mm. For smaller pipe diameters, stencil marking height shall be a minimum of 10 mm.

Marking of test pressures, size (diameter and wall thickness) and weight shall be in metric units.

10.2 LOCATION OF MARKINGS

Replace this section with the following:

Unless specified otherwise on the purchase order, marking shall be located as follows. For pipe diameters DN 450 (18"OD) and larger, all paint markings shall be on the inside surface. For smaller pipe diameters, the paint marking shall be on the outside surface.

10.3 SEQUENCE OF MARKINGS

Insert before clause a.:

The following sequence of markings shall be applied - a, b, c, d, e, f, g, h, i. In addition, the words "DEP 31.40.20.32-Gen." shall be included in the stencil area.

10.5 DIE STAMPING

Replace this section with the following:

Die stamping shall be carried out on the carbon steel base metal only.

Bevel faces of pipe with a wall thickness of 10 mm or greater shall be die-stamped at both ends with a unique pipe identity number, starting approximately 50 mm from the longitudinal weld in welded pipe. Low stress dies shall be used.

Cold die stamping on other parts of pipes is prohibited.

10.6 SURFACE TREATMENT

Replace this section with the following:

Scale, spatter and annealing surface residues of the CRA layer shall be removed by either pickling, brushing with a stainless steel brush or a combination of these methods.

Add new section:

11. PACKING AND HANDLING

11.1 GENERAL

All pipes shall be cleaned, dried, packed, handled and transported so as to arrive at their destination dry and without distortion or other damage.

11.2 METHOD OF PACKING AND STORAGE

All pipe shall be packed and stored in accordance with a procedure agreed by the Principal. The packing shall prevent the ingress of moisture or dirt into the pipe. Pipe ends shall be protected by caps.

The pipe shall be suitably protected from environmental contamination during storage and shipment.

11.3 TRANSPORTATION AND HANDLING

During transportation, direct contact of the clad side of the pipe with carbon steel (e.g. swarf, filings, hooks etc.) shall not be allowed.

The minimum requirements for transportation shall be as specified in the following Recommended Practices:

- API RP 5L5 for marine transportation
- API RP 5L1 for railroad transportation.

Pipe handling by means of hooks in pipe ends is prohibited. Pipes transported by sea shall not be shipped as deck cargo.

11.4 DOCUMENTATION

The packing of the pipe in accordance with the agreed procedure shall be confirmed by a certificate which will be included in the manufacturing data book.

Each shipment shall be accompanied by a packing list, the manufacturing procedure specification (Section 12.3), the welding procedure specification if applicable (Section 12.4.a), the procedure qualification record (Section 12.4.b), and the welding operator qualifications, if applicable (Section 12.4.c).

Add new section:

12. DOCUMENTATION

12.1 LANGUAGE

All documentation shall be in the English language.

12.2 PREFABRICATION DOCUMENTATION

The quality plan (Section 1.5) and (Appendix G) shall be submitted to the Principal for approval at least two weeks prior to the pre-manufacturing meeting (see Appendix F).

The welding procedure specifications, including those for repairs, shall be submitted to the Principal for approval at least three weeks prior to the pre-manufacturing meeting.

The inspection procedures including NDT, hydrostatic testing and packing procedures shall be submitted to the Principal for approval at least three weeks prior to the pre-manufacturing meeting.

If there will not be a pre-manufacturing meeting, the above documentation (quality plan, welding procedure specifications and inspection procedures) shall be submitted to the Principal for approval at least five weeks prior to the start of production.

The welder and welding operator certificates shall be available for review by the Principal prior to the start of pipe fabrication.

Mill certificates of the base metal and cladding shall be available for review by the Principal prior to the start of pipe fabrication.

12.3 MANUFACTURING PROCEDURE SPECIFICATION

The Manufacturer shall produce a manufacturing procedure specification which shall be submitted for the Principal's approval at least five weeks prior to the start of production. The manufacturing procedure specification shall include at least the following:

a. Steel Supply:

- Steel maker
- Steel making and casting techniques including details of the following:
  - Details of steel making process, including deoxidisation and desulphurisation practice, inclusion shape control method and the use of vacuum degassing.
  - Details of casting process i.e. ingot or continuous casting, including casting speed, tundish superheat, segregation and control measures.
  - Details of plate and strip manufacture, including slab reheating temperatures, start and finish rolling temperatures and reduction ratios.
- Heat treatment
- Chemical composition:
  (a) Target Chemistry
  (b) Ranges for deliberately added elements
  (c) Maxima for other elements specified in (Section 3.7).

b. CRA Supply:

- CRA maker
- CRA making and casting techniques including details of the following:
  - Heat treatment
- Chemical composition:
  (a) Target Chemistry
  (b) Ranges for deliberately added elements
  (c) Maxima for other elements specified in (Section 3.1).

c. Clad Steel Plate (if applicable):

- plate manufacturing method including details of specialised cooling and heat treatment
- plate NDT procedure.

Items (a), (b) and (c) may be combined in one report.

d. Each Pipe (or jointer):

- reference to base and clad/lined materials
- purchase order number
- applicable specification number
- grade designation of base material and cladding
- pipe heat treatment procedure (if appropriate)
- pipe forming procedure
- hydrostatic test procedure and results
- NDT procedure and results
- repair procedure
- confirmation of implementation of packing procedure.

12.4 WELDING

12.4.a Welding Procedure Specifications (WPS)

Welding procedure specifications shall be provided by the Manufacturer for both longitudinal and jointer girth welds (if applicable) and shall include details of the following:

- welding process
- brand name, classification, size and grade of filler metal and flux
- speed of welding
- number of electrodes and polarity for each electrode
- welding current for each wire
- welding voltage for each wire
- electrode stickout
- heat input
- dimensions of welding preparation
- number of weld passes
- details of seam tracking system for both inside and outside welding and also the method for checking the set up of the system
- limits on internal and external weld reinforcement
- repair welding procedure.

The WPS shall be prepared on a form which is internationally recognised, such as ASME IX.

12.4.b Procedure Qualification Record (PQR)

Welding procedure qualification shall be carried out for all procedures to be used including repair weld procedures in accordance with ASME IX. In addition, the requirements of (Section 4) shall be met. Procedure qualification shall be witnessed and signed by an independent authority and/or the Principal. The WPS and PQR shall be approved by the Principal before production is commenced.

For qualification of the welding procedure, the following tests shall be conducted on a full length test weld made in accordance with the manufacturing and welding procedure specifications, at least 48 hours after the completion of the test weld:

1. Ultrasonic Examination

The complete welded seam shall be examined in accordance with (Section 8.15).

2. Radiographic Examination

The complete welded seam of SAW pipe shall be examined in accordance with (Sections 8.4 to 8.11).

3. Dye Penetrant or Magnetic Particle Inspection

The complete welded seam shall be subjected to dye penetrant or magnetic particle inspection in order to check for surface defects in the weld material at both inside and outside of the pipe in accordance with (Section 13.2.d).

4. Tensile Tests

Two trans-weld tensile specimens shall be extracted and tested as detailed in ASME IX, QW 202.

5. All-Weld Tensile Tests

One specimen of the weld seam shall be subjected to an all-weld tensile test. Test results shall meet the minimum specified requirements of the plate with regard to yield, tensile strength and elongation.

6. Side Bends

Four side bend specimens shall be extracted and tested as detailed in ASME IX, QW 202.

7. Fracture Toughness Testing

Four sets of Charpy V-notch impact specimens shall be extracted and tested in accordance with (Section 4.20).

8. Macrographic, Micrographic and Hardness Testing

A specimen shall be removed from the weld seam and subjected to macrographic and micrographic examination. A hardness survey shall be carried out on a transverse weld macrosection as detailed in (Section 4.19).

9. Chemical Analysis

Chemical analysis of the weld overlay shall be conducted in accordance with (Section 5.4.b). The analysis shall meet the compositional requirements of (Section 3.1).

10. Witness

The preparation of the test weld and execution of the welding procedure qualification tests shall be witnessed by the Principal if specified.

12.4.c Welder or Welding Operator Qualification

All welders and welding operators shall be qualified in accordance with ASME IX, EN 287-1 or an equivalent internationally recognised standard approved by the Principal. Welder and welding operator qualifications may be witnessed if specified by the Principal.

12.5 MANUFACTURING DATA BOOK

The Manufacturer shall prepare and maintain the data book throughout manufacturing, comprising the following information:

- index
- quality plan
- manufacturing procedure specification
- procedure qualification records (if applicable)
- welding procedure specifications (if applicable)
- packing inspection certificate
- list of rejected pipe with reason
- record of repairs
- packing list.

Only original or certified copies of documents shall be included in the manufacturing data book. If the Principal has been involved in monitoring production and/or inspection (see Appendix F), the data book shall be completed by the Manufacturer and approved by the Principal before the Inspection Release Note will be issued. A copy of the Inspection Release Note shall be included in the data book for later reference. The master copy of the data book shall be retained by the Manufacturer for at least 5 years after delivery. A copy of the signed data book shall be submitted to the Principal.

12.6 TALLY LIST

The tally list accompanying the shipment shall give pipe numbers, charge numbers, length, weight and end dimensions.

Add new section:

13. FIRST DAY PRODUCTION TESTS

13.1 GENERAL

Three of the completely finished pipes of the first day's production shall be selected at random for testing to verify that the submitted manufacturing procedure results in fully acceptable pipe. If more than one heat is used in the first day production pipes, at least two heats shall be represented by the test pipes. At the Principal's discretion, the Principal may make the selection. For orders of less than 50 tonnes, first day production tests are not required.

The pipes tested as above may be considered the test pipe(s) per heat or shift as required by this DEP. The above first day production test shall be repeated after any change in the manufacturing procedure or interruption in the programme.

The Manufacturer shall submit to the Principal a report giving the results of all tests indicated below, together with macrographs of any weld cross-section, and micrographs confirming the microstructure of the plate and seamless pipe. The report shall be agreed and countersigned by the Principal.

If girth welding is used to produce double random length pipes, this girth weld shall be included in the first day production test. The girth weld from one completed pipe shall be tested.

13.2 NON-DESTRUCTIVE TESTING

13.2.a Visual Examination

All pipes shall be examined visually for dimensional tolerances and for surface defects in accordance with (Sections 7 and 9) respectively.

13.2.b Ultrasonic Examination

The weld seams of all pipes shall be examined by means of an automatic ultrasonic scanning device in accordance with (Section 8.15.a) and shall meet the requirements of (Section 8.15.d).

13.2.c Radiographic Examination

The weld seams of all pipes shall be radiographically examined throughout their full length in accordance with (Sections 8.4 to 8.12).

13.2.d Dye Penetrant Check or Magnetic Particle Test

The weld seams of all clad pipes greater than or equal to DN 600 (24 inch OD) shall be submitted to dye penetrant (internally) and magnetic particle inspection (externally), throughout their full length in order to check for longitudinal and transverse surface defects in the weld material. For pipe less than DN 600 (24 inch OD), the full length of the weld seam outside surface, plus the equivalent length of one and a half times the outside diameter at each end of the internal surface, shall be examined. Seamless pipe shall also be submitted to a dye penetrant or magnetic particle inspection over the entire outside pipe body.

Dye penetrant checking shall be in accordance with ASTM E 165 and magnetic particle testing in accordance with ASTM E 709.

Acceptance of discontinuities shall be in accordance with (Section 8.1.c). Cracks are unacceptable and their cause shall be investigated.

13.3 PHYSICAL TESTING

The physical properties of all pipes shall be tested as specified below. Test results shall meet the requirements for the specified grade and type of pipe.

13.3.a Weld Seam

The weld seam of all selected welded pipes shall be physically tested as specified in (Section 4). For SAW pipe, in addition, an all-weld metal tensile test shall be made including

the determination of tensile strength, yield strength and elongation. For determination of the elongation, the "Oliver" formula, as specified in ISO 2566-1 shall be used. Results of the all-weld metal tensile tests shall meet the minimum specified requirements of the plate, from which the pipe is made. For SAW pipe, in addition, weld impact tests shall be carried out in accordance with (Appendix E).

13.3.b Pipe Material

Tensile tests shall be carried out on the two pipes made from each end of a coiled skelp, or on two pipes made from different heats, as required by (Section 4), except that for pipes greater than DN 200 (8 inch OD), tensile tests shall be performed in both the transverse and longitudinal directions.

13.3.c Charpy Impact Tests

Tests shall be carried out on all selected pipes in accordance with (Section 4.20 and Appendix E). In addition, full transition temperature curves shall be produced, showing impact energy (in Joules) and percentage shear (fibrous) of the fracture surface, plotted against temperature, over a temperature range sufficient to reproduce fracture appearance from 10% to 100% fibrous shear.

13.3.d Drop Weight Tear Test

For pipe to be used in gas transmission lines, drop weight tear tests shall be carried out in accordance with (Section 4.20 and Appendix E).

13.4 MACROGRAPHIC, MICROGRAPHIC AND HARDNESS EXAMINATION

13.4.a Longitudinally Welded Pipe

For SAW pipe, a specimen shall be extracted from one pipe at three locations along the weld.

These three specimens shall be cross-sectioned, polished and etched for macro-examination.

This examination shall provide evidence that proper fusion has been obtained throughout the full thickness of the joint, the extent of interpenetration and the alignment of internal and external weld passes.

A series of Vickers hardness tests (HV 10) shall be made on one of the etched specimens selected by the Principal. This series of readings shall extend from unaffected base metal on one side of the weld and across the weld itself to unaffected base metal on the other side. Three traverses shall be made, one 2 mm from the outer edge, the second across the centre and the third 2 mm from the inner edge of the steel pipe. The spacing between the hardness impressions shall be 0.75 mm. The location of the hardness impressions are shown in (Figure A). The hardness impressions nearest the fusion line shall be within 0.5 mm of the fusion line.

13.4.b Seamless and Centrifugally Cast Pipe

Three specimens from one pipe shall be extracted from locations 120° apart from a position chosen by the Principal, polished and etched for examination and checked for microstructure. A hardness survey shall be made on one of the above specimens selected by the Principal. Three traverses shall be made, one 2 mm from the outer edge, the second across the centre and the third 2 mm from the inner edge of the steel pipe. A minimum of twelve readings per traverse shall be taken, each separated by at least 5 mm.

13.4.c Acceptance Criterion

No hardness measurement shall exceed 325 HV10.

13.5 TEST FOR BONDING

The continuity of the bonding between the steel base metal and CRA layer shall be tested in accordance with (Section 5.3).

PART III REFERENCES

In this DEP, reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments, supplements or revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Linepipe for use in oil and gas operations under non-sour conditions (Amendments/supplements to API Spec 5L)	DEP 31.40.20.30-Gen.

AMERICAN STANDARDS

Specification for Line Pipe	ANSI/API Spec 5L 40th Edition, November 1992
Specification for CRA Clad or Lined Steel Pipe	ANSI/API Spec 5LD 1st Edition, January 1993
Railroad Transportation of Line Pipe	API RP 5L1
Marine Transportation of Line Pipe	API RP 5L5

Issued by:
American Petroleum Institute
Publications and Distribution Section
1220 L Street Northwest
Washington DC 20005
USA.

ASME Boiler and Pressure Vessel Code: Section V: Non-destructive examination	ASME V
Section VIII: Rules for construction of pressure vessels	ASME VIII
Section IX: Qualification standard for welding and brazing procedures, welders, brazers, and welding and brazing operators	ASME IX

Issued by:
American Society of Mechanical Engineers
345 East 47th Street
New York NY 10017
USA.

Standard specification for heat-resisting chromium and chromium-nickel stainless plate, sheet, and strip for pressure vessels	ASTM A 240
Standard specification for stainless chromium-nickel steel-clad plate, sheet, and strip	ASTM A 264
Standard test methods and definitions for mechanical testing of steel products	ASTM A 370
Standard Test methods, practices and terminology for chemical analysis of steel products	ASTM A 751

Standard specification for ni-fe-cr-mo-cu alloy (UNS N08825 and UNS N08221) plate, sheet, and strip	ASTM B 424
Standard specification for nickel-chromium-molybdenum-columbium alloy (UNS N06625) plate, sheet, and strip	ASTM B 443
Standard test method for measurement of coating thickness by the magnetic method: nonmagnetic coatings on magnetic basis metals	ASTM B 499
Standard test methods for determining average grain size	ASTM E 112
Practice for liquid penetrant examination	ASTM E 165
Standard practice for flux leakage examination of ferromagnetic steel tubular products	ASTM E 570
Standard guide for magnetic particle examination	ASTM E 709

Issued by:
American Society for Testing and Materials
1916 Race Street
Philadelphia PA 19103
USA.

GERMAN STANDARDS

Ultrasonically Tested Heavy Plate Technical Delivery Specifications	SEL 072

Issued by:
Stahl-Eisen-Lieferbedingungen
Deutsches Institut für Normung
Burggrafenstrasse 6
Postfach 1107
D-10772 Berlin
Germany.

EUROPEAN STANDARDS

Approval testing of welders; fusion welding; Part 1: steels	EN 287-1

Issued by:
CEN - Comité Européen de Normalisation
Secrétariat Central
Rue de Stassart 36
B-1050 Brussels
Belgium.
Copies can also be obtained from national standards organizations

INTERNATIONAL STANDARDS

Radiographic Image Quality Indicator for Non-destructive Testing	ISO 1027
Non-magnetic coatings on magnetic substrates; Measurement of coating thickness; Magnetic method	ISO 2178
Steel, conversion of elongation values Part 1 Carbon and low alloy steels	ISO 2566-1

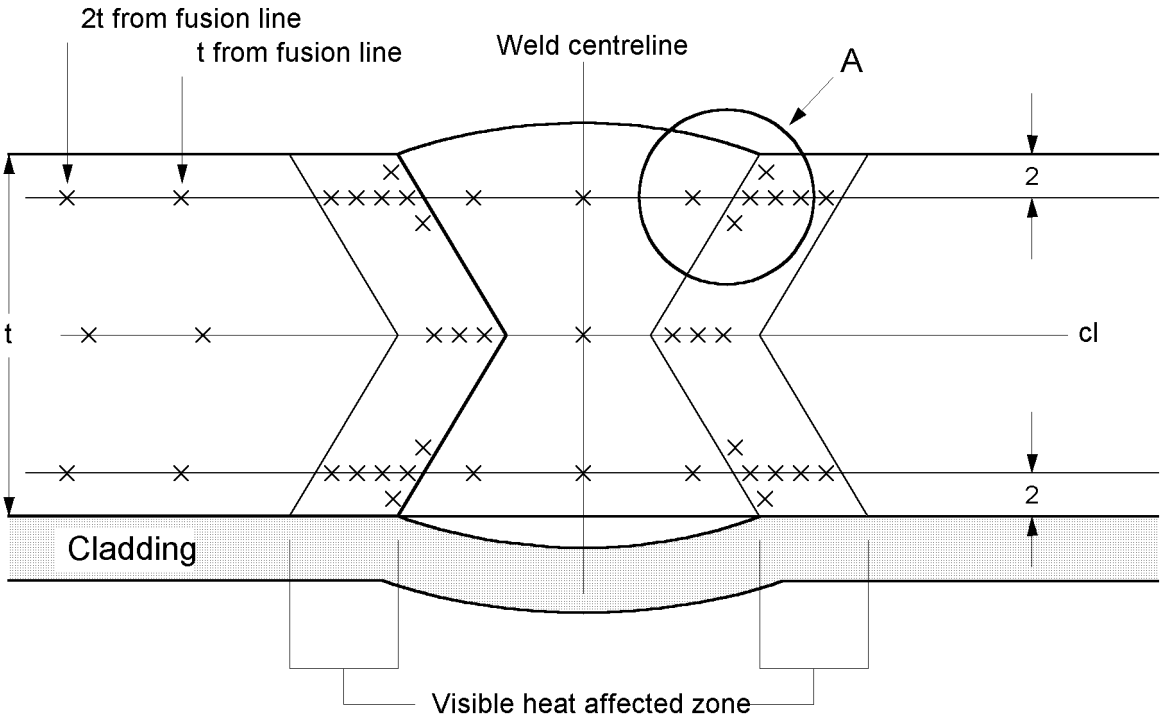
Quality systems - Model for quality assurance in design/development, production, installation and servicing	ISO 9001
Non-destructive testing; qualification and certification of Personnel	ISO 9712
Steel and steel products, inspection document	ISO 10474

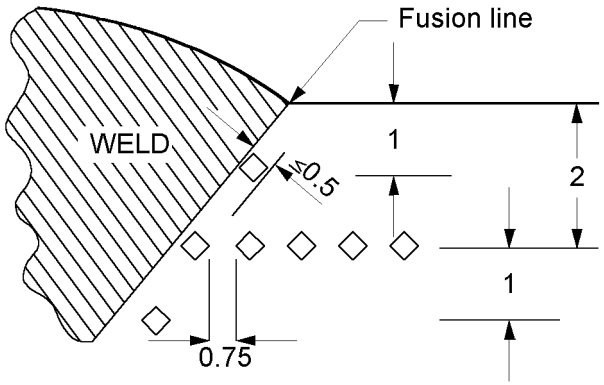
Issued by:
International Organization for Standardization
1, rue de Varembé
CH-1211 Geneve 20
Switzerland.

Copies can also be obtained from national standards organizations

FIGURES

FIGURE A LOCATIONS FOR THE LONGITUDINAL WELD HARDNESS SURVEY





Enlargement of area A
(all dimensions in millimetres)

FIGURE B1 LOCATION OF CHARPY V-NOTCH SPECIMENS IN SAW PIPE WELDS

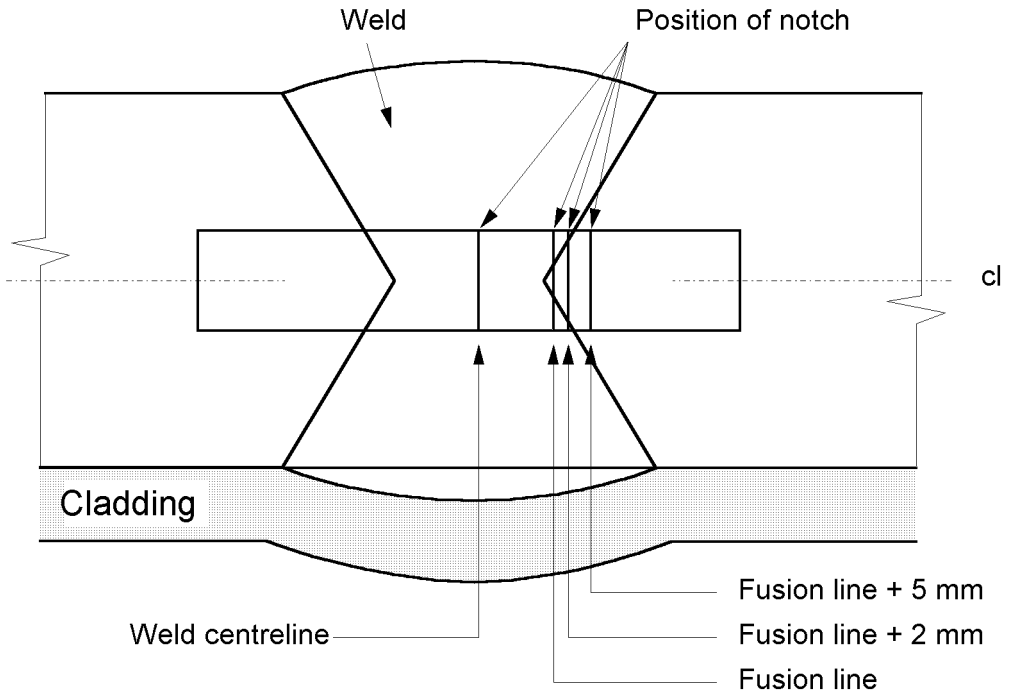
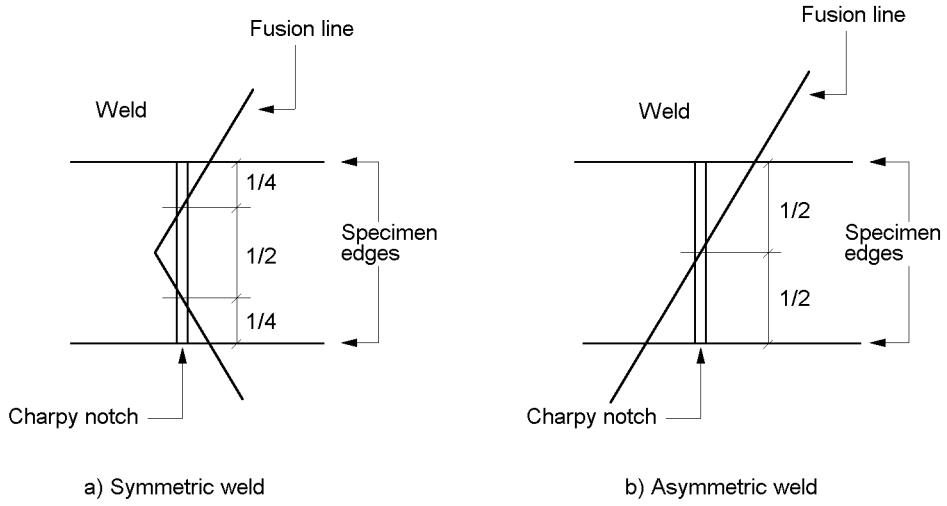


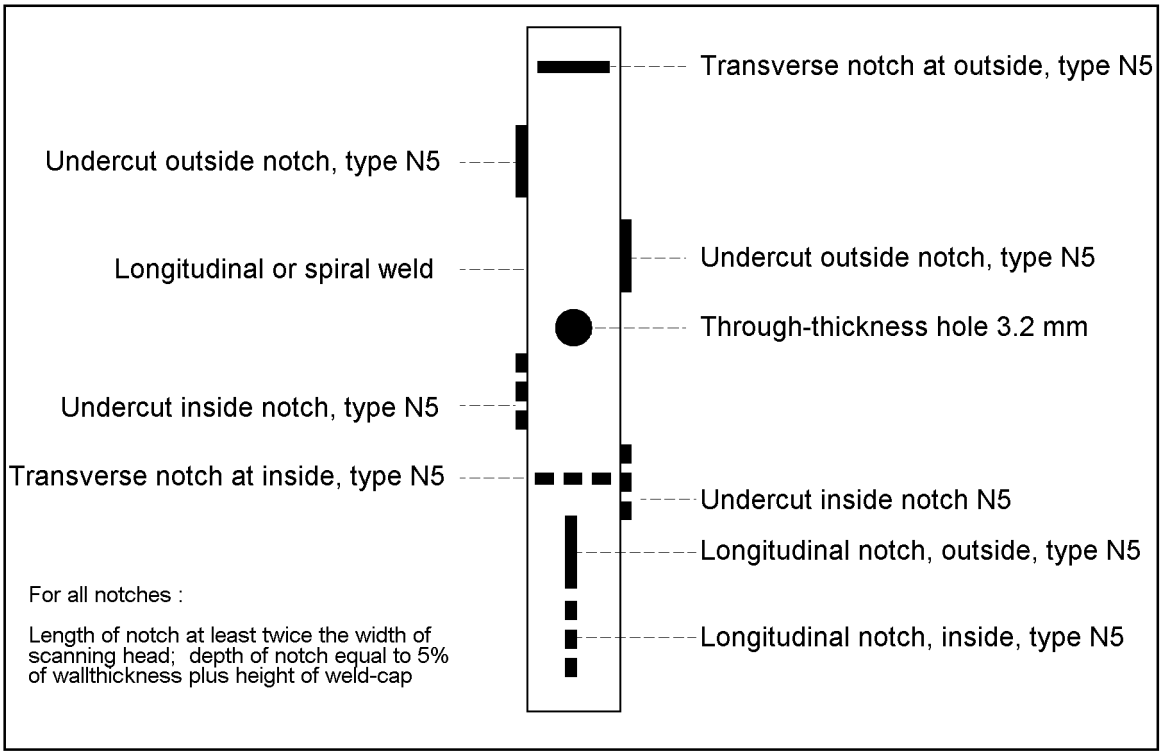
FIGURE B2 DETAIL OF FUSION LINE CHARPY NOTCH LOCATION



APPENDIX D REFERENCE STANDARD PIPE/PLATE FOR INSPECTION OF WELDS

Type and size of notches shall be as given in API Spec 5L, Part II, Section 9.15.

TEST PLATE OR SECTION FOR SAW PIPE*



*The location of each reference standard may be at the Manufacturer's discretion, provided that no interference will occur.

APPENDIX E FRACTURE TOUGHNESS TESTING

Fracture toughness testing shall be carried out in accordance with API Spec 5L, Appendix E (SR5 and SR6) together with the following amendments:

SUPPLEMENTARY REQUIREMENT SR5

SR5.1

Replace this section with the following:

The fracture toughness of the pipes shall be determined by Charpy V-notch impact testing in accordance with ASTM A 370. The impact test temperature shall be lower than or equal to that specified in the table below.

Nominal wall thickness (mm)	Test temperature (°C)	Maximum test temperature (°C)
wt $\leq$ 16.0	T	0
16.0 < wt $\leq$ 25	T - 10	0
25 < wt $\leq$ 32	T - 20	0
wt > 32	T - 30	0

T is the minimum design temperature, which shall be specified in the purchase order. If no minimum design temperature is indicated, it shall be taken as 0 °C.

SR5.4

Replace this section with the following:

Impact testing shall be carried out using 10 × 10, 10 × 7.5 or 10 × 5 mm cross-section specimens. The largest possible specimen shall be used. Where the nominal pipe dimensions are insufficient to extract a 10 × 5 mm specimen, impact testing is not required.

For pipes of DN 250 (10 inch) or less, impact test specimens shall be taken parallel to the axis of the pipe (i.e. longitudinal specimens shall be taken).

For pipes greater than DN 250 (10 inch), impact test specimens shall be taken transverse to the axis of the pipe, except where the wall thickness prevents extraction of a 10 × 5 mm specimen. In this case, longitudinal specimens shall be taken.

For weld centreline and HAZ impact tests, only transverse specimens shall be used.

SR5B.2

Replace this section with the following:

One set of three specimens shall be taken from the mid-thickness location in the pipe wall with the notch at the following positions (see Figure B1):

Seamless/Centrifugally Cast pipe	-	Pipe body
SAW pipe	-	Pipe body at 90° to the weld
	-	Weld centreline
	-	Fusion line
	-	Fusion line + 2 mm
	-	Fusion line + 5 mm

SR5B.3

Replace this section with the following:

The minimum absorbed energy requirements for full size (10 × 10) specimens taken transverse to the pipe axis are given in the table below.

GRADE	MINIMUM AVERAGE VALUE (J)	MINIMUM INDIVIDUAL VALUE (J)
X52	36	27
X56	39	29
X60	41	31
X65	45	34

For other specimen sizes and orientations, the values above shall be multiplied by the following factors:

SIZE	ORIENTATION	FACTOR
10 × 10	Longitudinal	1.5
10 × 7.5	Transverse	0.75
10 × 7.5	Longitudinal	1.125
10 × 5	Transverse	0.5
10 × 5	Longitudinal	0.75

The shear area at the fracture surface of the test specimens shall be recorded. Each sample shall exhibit not less than 50% fibrous shear.

The Charpy test requirements specified are based on crack initiation principles. For gas transmission and two-phase lines, higher absorbed energy requirements may be specified to avoid the risk of running fractures. In this case, the Principal shall specify the required values in the purchase order.

SUPPLEMENTARY REQUIREMENT SR6

SR6.1

Replace this section with the following:

Drop weight tear tests are required on pipes of DN 400 (16 inch) and greater.

SR6.2

Replace this section with the following:

Two transverse DWTT specimens shall be taken from one length of pipe from each heat supplied in the order. The specimens shall be taken at the locations shown in Figure SR6.1. Tests shall be performed at the minimum design temperature.

Full transition curves shall be established for one heat in every ten, with a minimum of one.

SR6.4

Replace this section with the following:

All specimens shall exhibit a minimum of 75% shear on the fracture surface.

APPENDIX F INSPECTION BY THE PRINCIPAL

Inspection by the Principal shall take place in accordance with API Spec 5L, Appendix G and the supplements given below.

G1 INSPECTION NOTICE

Add to the existing section:

The Principal shall specify if, and to what extent, he will monitor the Manufacturer's production, quality control, inspection and documentation. The Principal will specify whether or not a pre-manufacturing meeting is required.

G2 PLANT ACCESS

Add to the existing section:

Sufficient (more than 500 lux) lighting both overhead and at pipe ends shall be provided at the inspection area. Facilities shall be provided for rolling each pipe joint for inspection. The Manufacturer shall make ultrasonic or other suitable equipment available for use by the Principal to check the wall thickness where any defects have been ground out of the carbon steel base pipe.

G4 REJECTION

Add to the existing section:

If the Principal has to reject pipe repeatedly for any recurring cause, this shall be reason to refuse further pipes for final examination until the cause has been rectified.

APPENDIX G MINIMUM REQUIREMENTS FOR THE QUALITY PLAN

The Quality Plan shall include:

1. List of contents.
2. The date of issue, revision number and person(s) responsible for the execution of the Quality Plan.
3. A 'Statement of Authority' confirming the authority of the document.
4. References detailing the document upon which the plan is based, i.e. the Manufacturer's Quality Manual or the Purchase Order and Specification.
5. The Manufacturer's organisation, indicating names, responsibilities and reporting lines.
6. The procedure for the revision of actions included in the Quality Plan, before and during manufacture.
7. The procedure for providing the Principal with the required information and documentation (Sections 11.4 and 12).

   The number of copies of documents will be specified by the Principal when approving the Quality Plan.
8. Access arrangements for the Principal and facilities at his disposal (Appendix F).
9. A flow diagram showing all of the proposed tests and inspection in the sequence of fabrication, and indicating:

   - pipe fabrication stage
   - welding procedure applied
   - inspection action
   - location
   - relevant inspection procedure
   - acceptance criteria
   - responsibility to carry out inspection
   - involvement of Principal (Witness, Review, Hold).

10. Copies of all the applicable manufacturing, test and inspection procedures referenced including:

    - title
    - revision number
    - date
    - author
    - authority for approving changes.

APPENDIX H SUMMARY OF TESTING AND INSPECTION

Types of Test/Inspection	First-day Production Tests		During Production	
	Frequency	Remarks	Frequency	Remarks
VISUAL INSPECTION (Sections 2.4.a.1, 9.3 and 13.2.a)				
- surface defects	all pipes	external (plus internal ≥ DN 600)	all pipes	external (plus internal ≥ DN 600)
- surface defects	all clad plates	100% coverage	all clad plates	100% coverage
- dimensions	all pipes		all pipes	
- out-of-roundness at weld position	all SAW pipes		all SAW pipes	
- pipe end squareness	all pipes		2 pipes per shift	only pipes > DN 500
- straightness	all pipes		random	
ULTRASONIC EXAMINATION (Sections 2.4.a.2, 8, 12.4.b.1 and 13.2.b)				
- clad plate	all plates	100% coverage for disbonding/ lamination 25 mm of plate ends	all pipes	100% coverage for disbonding/ lamination 25 mm of plate ends
- pipe ends	all pipes	25 mm of pipe ends	all pipes	25 mm of pipe ends
- welded pipe				
- plate/skelp	all plates/skelp	25 mm of trimmed plate material 100% coverage for disbonding/ laminations	all plates/skelp	25 mm of trimmed plate material 100% coverage for disbonding/ laminations
- weld seam	all pipes	SAW pipe ends shall be radiographed	all pipes	SAW pipe ends shall be radiographed
- seamless/centrifugally cast pipe	all pipes	100% coverage for disbonding/ laminations 25% coverage for thickness of base and cladding (if applicable)	all pipes	100% coverage for disbonding/ laminations 25% coverage for thickness of base and cladding (if applicable)
RADIOGRAPHY (Sections 8, 12.4.b.2 and 13.2.c)				
- weld seam	all selected SAW pipes	100% of weld	all SAW welds	end 200 mm
- repair welds	all weld repairs		all weld repairs	
MPI*/DYE PENETRANT CHECK (Sections 2.4.a.3, 8, 12.4.b.3 and 13.2.d)				
- bevel faces	all pipes	only if ultrasonic testing is impossible	all pipes	only if ultrasonic testing is impossible
- weld seam	all selected pipes	100% of weld	all selected pipes	100% of weld
- seamless pipe body	all selected pipes	100% of weld	all selected pipes	100% of weld
ELECTROMAGNETIC TECHNIQUES (Section 8)	all pipes	25% of surface area to check CRA thickness	all pipes	25% of surface area to check CRA thickness

* Magnetic Particle Inspection (MPI) is not applicable to the austenitic CRA layer.

Types of Test/Inspection	First-day Production Tests		During Production	
	Frequency	Remarks	Frequency	Remarks
PHYSICAL TESTS **(Sections 4, 12.4.b and 13.3)**				
- Tensile test	two selected pipes	base metal only	two pipes per heat	base metal only
- Weld tensile test	all selected pipes	base metal of welded pipe only	two pipes per heat	base metal of welded pipe only
- All weld tensile test	one pipe	SAW only		
- Charpy V-notch **(Appendix E)**	all pipes		all selected pipes	
- at temperature in Part II, App. E	all selected pipes	base metal only	as required for tensile test	base metal only
- transition curve	one pipe	base metal only		
- Drop weight tear test				
- transition curve	one pipe	base metal only	one pipe per ten heats	base metal only
- at minimum design temperature	all heats	base metal only	all heats	base metal only
- Weld manipulation test			one pipe per 50 pipes	SAW only
- Guided bend test	all selected pipes		two pipes per heat	
- Hardness test	all selected pipes	base metal only	all selected pipes	base metal only
HYDROTEST **(Section 6)**	all pipes		all pipes	
CHEMICAL COMPOSITION **(Section 3 and 5.4.b)**				
- Ladle analysis	once per heat		once per heat	
- Check analysis	twice per heat		twice per heat	
- Weld overlay	all selected pipes	CRA layer only	all selected pipes	CRA layer only
METALLOGRAPHIC EXAMINATION **(Sections 5.4a, 12.4.b and 13.4)**	once per heat	welded pipe only	once per heat	welded pipe only