

GENERAL SPECIFICATION

PIPELINES - RISERS

GS EP PLR 208

Duplex and Super-Duplex Stainless Steel Pipe Manufacturing for Pipeline Applications

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1. Scope

This specification defines Company general requirements for the manufacture and supply of bare Duplex and Superduplex stainless steel pipes.

It applies to seamless pipes and longitudinally Submerged Arc Welded pipes with filler metal (SAWL) over 16" manufactured by UOE, JCOE, JCO, Press Bending Process or Roll Bending processes.

This specification covers Line pipe for onshore and offshore application (including reeling installation), operating in sweet service or sour service environments according to severity limitation of [ISO 15156-3](#) and [GS EP COR 170](#).

This document applies to pipes manufactured in accordance with [API SPEC 5LC](#).

This specification may also be applied to line pipe manufacturing for pipelines designed according to other design standards.

It is the responsibility of the manufacturer to comply with the manufacturing requirements of both the selected design code and this specification.

If conflicts arise between this specification and [API SPEC 5LC](#) or other manufacturing standard (or its referenced documents) then the most stringent requirements are applicable.

2. Normative references

2.1 External Documents

If conflicts arise between this specification and [API SPEC 5LC](#) (or referenced documents) then the most stringent requirements shall be applied.

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published at the effective date of this document.

Reference	Title
API RP 5L1	Recommended Practice for Railroad Transportation of Line Pipe
API RP 5LT	Recommended Practice for Truck Transportation of Line Pipe
API RP 5LW	Recommended Practice for Transportation of Line Pipe on Barges and Marine Vessels
API SPEC 5LC	CRA Line Pipe
ASME B31.4	Pipeline Transportation Systems for Liquids and Slurries
ASME B31.8	Gas Transmission and Distribution Piping Systems

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Reference	Title
ASME BPVC Section II Part C	ASME Boiler and Pressure Vessel Code, section 2 Materials Part C-Specifications for Welding Rods Electrodes and Filler Metals
ASTM A370	Standard test methods and definitions for mechanical testing of steel products
ASTM A380	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A923	Standard Test Methods for Detecting Detrimental Intermetallic Phase in Duplex Austenitic/Ferritic Stainless Steels
ASTM E165	Standard Practice for Liquid Penetrant testing for General Industry
ASTM E45	Standard Test Methods for Determining the Inclusion Content of Steel
ASTM E562	Standard Test Method for Determining Volume Fraction by Systematic Manual Point Count
ASTM G48	Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution
BS 7448-1	Fracture mechanics toughness tests. Method for determination of K_{Ic} , critical CTOD and critical J values of metallic materials
DNVGL-RP-F112	Duplex stainless steel-design against hydrogen induced stress cracking
DNVGL-ST-F101	Submarine Pipeline Systems
EN 10204	Metallic products - Types of inspection documents
ISO 10893 (All parts)	Non destructive testing of steel tubes - All parts
ISO 12135	Metallic materials - Unified method of test for the determination of quasistatic fracture toughness

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Reference	Title
ISO 15156-3	Petroleum and natural gas industries - Materials for use in H ₂ S-containing environments in oil and gas production - Part 3: Cracking-resistant CRAs (corrosion resistant alloys) and other alloys
ISO 15653	Metallic materials - Method of test for the determination of quasistatic fracture toughness of welds
ISO 17025	General requirements for the competence of testing and calibration laboratories
ISO 17640	Non-destructive testing of welds - Ultrasonic testing - Techniques, testing levels, and assessment
ISO 9001	Quality managements systems - Requirements
ISO 9712	Non-destructive testing - Qualification and certification of NDT personnel
ISO/TS 29001	Petroleum, petrochemical and natural gas industries - Sector-specific quality management systems - Requirements for product and service supply organizations
NACE TM 0177	Laboratory Testing of Metals for Resistance to Sulfide Stress Cracking and Stress Corrosion Cracking in H ₂ S environments

2.2 Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendum, is the latest revision published.

Reference	Title
GS EP COR 170	Materials for upstream sour service application. Specification for selection and design
GS EP PVV 175	Cleaning of piping systems

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3. Definitions and Abbreviations

For the purpose of this document, the following terms and definitions apply.

3.1 Definitions

Inspector	The Company's representatives or members from an Inspection Agency duly appointed by the Company and thus notified to the Manufacturer, shall be referred to herein as the "Inspector". The inspector is not to be amalgamate to a third party.
Company	TOTAL S.A.; Company Referential Authority is the entity responsible for the technical aspects within this specification (HQ Pipelines & Risers Entity).
Contract	The Purchase Order together with all material requisitions, specifications, etc., issued by the Company and/or Company and attached to the contract or the purchase order shall be referred to herein as the "Contract".
Approval	Authorization in writing given by the Company to the Manufacturer on a procedure or to proceed with the performance of a specific part of the work without releasing in any way the Manufacturer from any of its obligations to conform to the technical specifications, requisitions, etc., "approve", "approved" and "approval" shall be construed accordingly.
PPS	Project Particular Specification

3.2 Abbreviations

CTOD	Crack Tip Opening Displacement
GMAW	Gas Metal Arc Welding
GTAW	Gas Tungsten Arc Welding
HAZ	Heat Affected Zone
HIC	Hydrogen Induced Cracking
ID	Inside Diameter
LPI	Liquid Penetrant Inspection
MPS	Manufacturing Procedure Specification
MPQT	Manufacturing Procedure Qualification Test
NDT	Non Destructive Testing
OD	Outside Diameter
PQR	Procedure Qualification Record
PREN	Pitting Resistance Equivalent Number

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SAW	Submerged Arc Welding
SMAW	Shielded Metal Arc Welding
SMLS	SeaMLesS
SMTS	Specified Minimum Tensile Strength
SMYS	Specified Minimum Yield Strength
SSC	Sulfide Stress Cracking
Tmin	Minimum design temperature
WPS	Welding Procedure Specification
WT	Wall Thickness

4. Compliance to this Standard

4.1 Quality Assurance/Quality Control

Manufacturer(s) shall be previously audited and approved by Company.

Company can suspend the approval of a manufacturer due to a negative feedback concerning quality, delivery time, missing documentation or HSE issues.

All sub-suppliers (e.g. raw material supply, NDT, etc.) shall be clearly identified at the bid stage and be approved by Company.

The Manufacturer and its sub-suppliers shall operate a Quality Assurance system in accordance with [ISO 9001](#) or [ISO/TS 29001](#), approved by a Company recognized authority. Laboratory used for testing shall be certified according to [ISO 17025](#).

The Quality Manual shall be submitted prior the start of work. It shall be demonstrated that a continuous improvement program is in place.

Responsibility for quality control shall rest with the Manufacturer aided by such staff as may be required. Company may perform or delegate second party inspection during the entire manufacturing.

The Manufacturer shall maintain quality records as documentary evidence of compliance with quality requirements.

Quality records shall be available to the Inspector for analysis and review.

4.2 Production

Pipe production including MPQT shall not start without the approval of the Company and until a pre-production meeting has been held between the Company and its representatives and the Manufacturer.

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Just before production, mill QA Representative accompanied by Inspector shall check that the relevant working instructions and procedures are available, complete, conform to the procedures agreed by Company or to Company specification requirements at every production and inspection station.

Pre-production meeting report and mill readiness inspection report shall be issued by Manufacturer, signed by Inspector and enclosed with the final dossier.

An appropriate system shall be put in place to alert the operator if there is any deviation to the approved process parameters.

The incidence shall be recorded in the logbook and be available upon request at the QA/QC department.

The Manufacturer shall submit daily production and inspection reports to Inspector within 48 hours after completion of the inspection.

4.3 Inspection by the Company

All qualification tests shall be witnessed by the Inspector.

The Manufacturer shall notify the Company and Inspector sufficiently in advance to enable him to be present at qualification tests and at all other tests or stages of manufacture subject to acceptance in accordance with this specification.

The Manufacturer shall ensure that the Company and Inspector have free access to all parts of the Mill during all manufacturing and inspection stages (from steel to pipe making)

Manufacturer shall provide details as a minimum on:

1. Production tracking system and inspection status (e.g.: tests results)
2. Rejection rate and rejection status with associated causes and repairs
3. Any other information considered pertinent by the Inspector for his monitoring

The Manufacturer shall make available computer and software compatible with the mill computer system where production data can be exported into spreadsheets to the inspector.

The Inspector shall be provided with facilities/equipment for printing, communicating by emails and fast Internet access.

Where the mill country language is not English, all these information shall be written in double language, i.e. mill country language and English language.

If specified in the PPS, the Inspector shall finalize its inspection by the application of a special stamp (or indelible paint marking, when so previously agreed).

Die stamping is permitted only on the pipe end surface.

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The Manufacturer shall notify the Company and Inspector without delay of any difficulty, irregularity, problem or delay likely to occur during production.

The Company reserves the right to cross check tests carried out by the Manufacturer.

For this purpose, the Company may request the delivery of the corresponding samples or specimens to be analyzed in an independent laboratory chosen by the Company.

If during the main production, more than 10% of the pipes are rejected in any day's production or re-routed for repairs or re-processing, then the Company and/or Inspector are entitled to require Manufacturer to increase his Quality Control Program to an appropriate level and to maintain it until the causes of the defective quality are identified and eliminated.

A Corrective Action request will be send by Inspector to Manufacturer.

Production is not acceptable until a response with positive results is accepted by Inspector.

Where above rate reaches 15%, the Company and/or Inspector may require the main production to be stopped. In such a case Company requires a program of investigation to determine the root cause(s) of the defective quality. This program will be established in mutual agreement between Company and Manufacturer.

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This program will be established in mutual agreement between Company and Manufacturer.

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The rest of production shall be put on hold until result of investigations and Company acceptance.

4.4 Technical queries/Non-conformance reports

Any work performance or test result which is found, after contract award, not in conformance with Company specifications or agreed procedure shall be subject to a Non-Conformance Report (NCR) to be issued by the Manufacturer for submission to Company.

NCR report shall indicate corrective action intended by the Manufacturer

NCR shall be submitted to the Inspector within 48 hours after the finding.

Manufacturer shall be fully responsible for complying with all of the applicable requirements of [API SPEC 5LC](#) and design code.

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5. Process of Manufacture and Material

5.1 Particular precaution

The following precautions shall be implemented:

- No contact between stainless steel and carbon steel
- Dedicated equipment / tools for stainless steels
- Use of grinding disks free from iron and carbon
- Stainless Steel brush
- Cutting only with plasma or mechanical sawing.

Contamination of surface with low melting point metals such as Copper, Zinc, etc., is not acceptable.

Paint and markers containing zinc or chloride are prohibited.

Correction of deflection by flame straightening is prohibited.

5.2 Steel making

Steel making shall be by use of the Electric Arc Furnace or Basic Oxygen Furnace.

Bloom, billets and slabs shall be produced from continuously strand cast.

Each bloom, billet and slab shall be free from injurious surface defects, and be correctly marked and stored to avoid any confusion between heats of steel. (e.g. heat n°, casting strand n° and sequential n°).

5.3 Plate manufacture

Macro-etching or sulfur prints shall be carried out on slabs (or plates) at a frequency of a minimum of once per shift and casting sequence, on each strand.

The Mill's reference chart of grading and acceptance level shall be agreed with the Company.

Steel plates shall show an homogeneous very fine-grained microstructure.

All calibration certificates of control devices, thermometers, recorders, shall be made available to Inspector's review prior to start the rolling campaign.

The rolling records of each mother plate shall be made available for review, on Inspector's request.

Except otherwise agreed between the Manufacturer and the Company, all inspections and tests required for steel plate acceptance shall be carried out at the Manufacturer's Mill.

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5.3.1 Mechanical Properties and Tests

If specified in the PPS, mechanical properties of the plates shall be measured by tensile and impact testing:

- Sampled once per heat, midway between edge and centre of plate and transverse to the principal rolling direction
- Tested using procedures and specimens as defined for finished pipes
- Meeting results of the working ranges stipulated by the Manufacturer at the bid stage.

5.3.2 Visual, dimensional and ultrasonic inspections

Steel plates shall be subject to visual, dimensional and ultrasonic inspections on finished product.

Visual and ultrasonic inspection may be carried out at the pipe mill.

5.3.2.1 Visual inspection

Steel plates shall be visually examined on both surfaces and be free from:

- Surface defects such as cracks, notches, laps, sharp bottom imperfections, tears, foreign materials, loose mill scale and rust.
- Any other imperfection having a depth greater than 3% of the specified nominal thickness or encroaching on the wall thickness.

Defect shall be repaired provided that the specified minimum wall thickness is maintained.

5.3.2.2 Thickness measurement

Two options can be considered:

Option 1: Wall thickness inspection shall be performed at both the plate and the pipe mill (refer to section 8.4.1).

On plate: once every ten plates, on middle, both edges and both plate ends.

Option 2: An automatic gauge control system (with recording) shall be used to measure, as a minimum, the wall thickness along the full plate length, on both plate axis and plate edge.

Calibration of this system shall be made minimum twice per month.

5.3.2.3 Ultrasonic inspection

Each steel plate shall be 100% ultrasonically inspected in accordance with the provisions stated in Annex E.

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Inspection records and print out charts of all plates (including calibration plates) showing locations and dimensions of reflectors shall be made available to the Inspector for review at the Mill.

5.3.2.4 Repairs

Welding repairs are not permitted on plates.

Plate may be repaired by grinding or cosmetic grinding (flap wheel or disks grain size # 100).

After grinding, complete removal of defects shall be verified by the NDT method which detected the defect followed by LPI.

Wall thickness measurements checks and records shall be made by UT in the ground areas (except for cosmetic grinding).

The final thickness after grinding shall be not less than the specified minimum wall thickness.

Wall thickness checks shall be recorded.

Marking of repaired area shall be made in such a way to be readable by the inspector when the pipe is presented at final bench.

5.3.2.5 Plates for Bend mother pipes

Before starting the bend mother pipe production, three specimens of 50 mm long shall be extracted in the rolling direction from a mother plate at 50 mm from each longitudinal edge and at mid width of the plate.

The cross sections from the rolling direction of the specimens shall be:

- Polished and etched to reveal carbides.
- Examined every 10 mm, at 5 mm from each surface and at mid wall, with a magnification of X100.
- Evaluated against micro-structure acceptance criteria set section 6.9.2.

Three photography of typical structure shall be issued for Company review and approval.

5.3.2.6 Marking of plates

Each plate shall be clearly identified by means of weather resisting markings and free of chloride.

The following minimum indications shall be marked on each plate:

- Company's name
- Plate Manufacturer and Mill name

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- Heat no.
- Plate no.
- Plate wall thickness x width
- Steel grade
- Order identification.

The Manufacturer's in-house plate marking may be proposed at bid stage for integrated plants if demonstration of the traceability is performed and if marking include as a minimum plate number and job identification.

5.3.2.7 Mill Certificates

The Manufacturer shall provide the Company with 3.2 Mill certificates according to [EN 10204](#).

Mill certificate shall contain all inspections reports (Heat and product analyses, mechanical tests, visual inspection, wall thickness measurements, ultrasonic inspection).

Each plate shall be identified with the heat and slab from which it has been produced.

The delivery condition shall be clearly stipulated.

Format of Mill certificates shall be agreed prior to production between the Company and the Manufacturer.

5.4 Pipe manufacture

5.4.1 Pipe Manufacturing Procedure Specification (MPS)

The Manufacturer shall establish a detailed specification for manufacture and inspection of pipes, describing all proposed operations in their correct sequence together with their parameters of execution.

The proposed specification shall include, but not limited to, all pertinent information required in Annex A.

This detailed specification shall be submitted to the Company four (4) weeks minimum before commencement of production.

5.4.2 Mother pipe for bends

Mother pipes for bends shall be of the same source, same manufacturing route and of similar chemical composition as the line pipes, unless otherwise agreed.

The mother pipe manufacturing procedures (chemical analysis of plate and of weld, welding procedure...) with prior approval from the Bend Manufacturer shall be submitted to Company at the bid stage.

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5.4.3 Seamless pipe

Seamless pipes shall be manufactured from billets by the hot rolling process using exclusively the Plug Rolling Mill Process or the Mandrel Mill Process.

i.e.: any other processes are not acceptable (i.e.: Pilger Mill, etc.).

Pipes shall be delivered in solution-annealed and water-quenched condition.

Pipe shall be sized, straightened and hydrostatically tested.

5.4.4 Welded pipes

5.4.4.1 Pipe forming

Pipes shall be manufactured from plates by following processes:

- Cold forming using the UOE or JCOE processes (i.e. with mechanical expansion)
- Press Bending process, JCO or the Roll Bending process (when so agreed with the company at the bid stage).

The longitudinal seam shall:

- Be welded by automatic Submerged Arc Welding process using filler metal
- Include at least one pass made on the inside and at least one pass made on the outside
- On completion, have the run-on and run-off tabs removed by plasma cutting or sawing only (no mechanical breaking of tabs).

5.4.4.2 Welding

A Welding Engineer shall be appointed to the mill and be available at any time in or close to the workshop.

He/She shall carry the responsibility for the welding quality management and will be the Company/Inspector interlocutor for all welding matters.

5.4.4.2.1 Welding processes

GTAW with filler metal, SAW or a combination of these processes shall be used.

Manufacturer shall submit the process for the tack-welding and demonstrate the full re-melting by the subsequent processes for Company approval at bid stage.

GMAW may be used for automatic tack welding only.

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5.4.4.2.2 Backing gas protection

Backing gas protection shall:

- Be Argon or a gas mixture (i.e. Ar + 2.5% N₂) approved by the Company before starting qualification tests.
- Be maintained during qualification tests as well as during fabrication until completion of the first three passes or a minimum of 5 mm of deposited weld metal.

The oxygen level in the backing gas protection (measured in the purging chamber) shall:

- Be less than 500 ppm
- Be checked and recorded during the qualification tests until the end of weld performance
- Be limited to, for production: the actual qualified level measured at the start of the qualification weld
- Be checked until completion of the first three passes or of 5 mm of deposited metal during production.

Before production start, the Contractor shall send for Company approval, method statement for back purging and oxygen level measurement.

The oxygen level measure could be continuous or discontinuous with a minimum record frequency to be agreed by Company.

5.4.4.2.3 Welding procedure qualifications

The welding procedure for longitudinal weld shall be qualified together with the pipe manufacturing procedure based on the submitted WPS.

Each welding procedure shall be qualified on a pipe section under realistic conditions to the satisfaction of the Inspector.

Maximum interpass temperature shall be 150°C for Duplex and 150°C for Superduplex.

5.4.4.2.4 Pipe cleanness

The weld bevel and surrounding areas shall be free from any lubricant, contamination, wet or damp prior to tack or main weld starts.

5.4.4.2.5 Tack weld

Tack welding shall be made by semi automatic process.

The tack welding height shall be indicated on WPS.

Repair of tack weld by manual welding may be allowed provided that the weld is ground down to the height of the automatic pass.

Intermittent tack welding shall not be used.

5.4.4.3 Heat treatment

Pipe shall be solution annealed after welding (including repair, if any).

5.4.5 Cold expansion

Estimated cold expansion ratio shall be indicated at the bid stage.

Cold expansion ration shall be qualified during MPQT and:

- Be within 0.8% to 1.5% for UOE pipes
- Be limited to 1.5% for seamless pipes
- Be recorded on 10 pipes per shift in production.

No cold expansion is required on Press Bending pipes, JCO and Roll Bending pipes.

6. Production testing requirements

6.1 General

Specimen cutting shall be by sawing or plasma cutting (No flame cutting).

Company reserves the right for Company representative to select the pipes to be tested, stamp the tests sampling and witness the test.

Production tests shall be carried out on base material and weld seam in accordance with selected manufacturing standard and additional requirements of Table 1.

Table 1 - Production test frequency

Item	Type of test	Type of pipes	Production test frequency ^e
1	Ladle analysis	All pipes	Once per heat
2	Ladle analysis including residual elements	All pipes	Every 10 heats
3	Product chemical analyses	All pipes	2 pipes per test unit
4	Tensile tests (Strip specimen) ^b	All pipes	1T + 1L per test Unit ^a
5	Transverse tensile testing of the weld seam	Welded pipes	1W per test Unit ^a

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Item	Type of test	Type of pipes	Production test frequency ^e
6	Guided bend tests	Welded pipes	2W per test unit of no more than 50 pipes
7	Base material impact test ^c	All pipes	1T90 per test Unit ^a
8	Impact testing of the seam weld	Welded pipes	1 WM + 1FL + 1HAZ per test Unit ^{a d}
9	Macrography and Hardness testing	All pipes	1T per test Unit ^a
10	Macrography and Hardness testing	Welded pipes	1W per test Unit ^a
11	Ferrite content	All pipes	1T per test Unit ^a
12	Ferrite content of the seam weld	Welded pipes	1W per test Unit ^a
13	Micrography	All pipes	2T per test Unit ^a
14	Micrography	Welded pipes	1W per test Unit ^a
15	Pitting corrosion resistance	All pipes	1 T per test Unit ^a
16	Pitting corrosion resistance of the seam weld	Welded pipes	1W per test Unit ^a

Notes:
^a A test unit is defined as:

- Pipe lot coming from a same size, grade, heat and manufactured in sequence and limited to:
 - for OD ≤ 4" ½: 200 pipes
 - for OD ≤ 12"3/4: 100 pipes
 - for OD > 12"3/4 : 50 pipes.

Any increase or decrease in the cold-expansion ratio of more than 0.002 requires the creation of a new test unit.

Any fraction of a lot remain subject to full testing as above.

^b Transverse tensile test: for OD equal to or greater than 8" 5/8.

^c Transverse impact testing: for pipe with OD equal to or above 4.5".

^d HAZ specimen: FL+2 or FL+5, whichever gave the lowest average value during MPQT testing.

^e W: cross weld sample, T: transverse direction, L: longitudinal direction.

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6.2 Chemical properties

6.2.1 Test method

The Manufacturer shall carry out heat and product analyses for all specified chemical elements and any other intentionally added elements.

Sampling method shall be in accordance with [API SPEC 5LC](#).

Sampling location (welded pipes):

Location of sampling shall be at midway between plate edges.

For integrated steel/plate/pipe mills, product analysis may be made on pipe instead of on plate provided that product traceability is fully demonstrated by Manufacturer to Company. The Manufacturer shall clarify the selected option at the bid stage.

6.2.2 Acceptance criteria

The mill shall propose the aimed chemical composition at the bid stage.

The chemical composition of MPQT and the entire ladle and product analysis shall be within the aimed one.

Pipes shall have chemical composition that meet the requirements of Table 2.

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Table 2 - Chemical composition

Chemical Element (see note 1)	Grades	
	LC65-22Cr DX	LC65-25Cr SDX
	Ladle & Check Analysis % Weight mini-max.	Ladle & Check Analysis % Weight mini-max.
C	0.030 max	0.030 max
Mn	2.00 max	1.00 max
Si	1.00 max	0.75 max
S	0.005 max	0.005 max
P	0.030 max	0.030 max
N	0.15-0.20	0.20-0.34
Ni	4.5-6.5	6.0-8.0
Cr	21.0-23.0	24.0-26.0
Cu	(2)	(2)
Mo	2.5-3.5	3.0-4.0
W	-	(3)
PREN (see note 4)	34 mini	42 min

Notes:

- (1) Intentionally added elements not specified in the table shall not be permitted without prior written approval from the Company.
- (2) Cu addition shall be subject to Company's written approval.
- (3) W addition shall be subject to Company's written approval.
- (4) $PREN = \%Cr + 3.3\% Mo + 16\% N$.

6.3 Tensile tests

6.3.1 Test method

Procedure for samples preparation and flattening shall be submitted to the Inspector.

Tensile test charts shall be recorded with a suitable scale and be part of test report.

Strip specimens shall be used for longitudinal and transverse tests.

If agreed, round bar specimens may be used where practicable for transverse tests.

Round bar specimens shall be machined without any flattening of the sample, as specified in [API SPEC 5LC Fig 2](#).

In case of dispute, the results with round bar specimens prevail.

If transverse tensile tests in base material using strip specimens show results within + 3% of the minimum specified Yield Strength, the Inspector may require additional tensile testing with round bar specimens located as close as possible to the strip specimen, to crosscheck the tensile properties.

Inspector may select production test pipes, according to the results of tensile properties obtained on plates, to check that mechanical properties have been obtained with plates having properties at the minimum of the tensile range.

6.3.2 Acceptance criteria

The Yield, Ultimate Tensile Strength, percentage Elongation and Ys/Ts ratio results shall be in line with Table 3.

Table 3 - Tensile requirements at room temperature (strip or round bar specimen)

Grade	YS min. (MPa)	TS (MPa)		Ys/Ts max	E1 % min.
		Min.	Max.		
LC65-22Cr DX	450	620	-	0.90	As per API SPEC 5LC
LC65-25Cr SDX	550	750	-	0.92	

For cross weld tensile test, acceptance criteria shall be:

- Weld metal properties over-matching the base metal properties
- Location of rupture: outside of the weld area.

6.4 Guided bend tests

Guided bend tests shall be:

- Sampled transverse to weld seam in accordance with the requirements of [API SPEC 5LC](#)
- Tested as one face-bend and one root-bend test for wall thickness of 12.7 mm and less
- Tested as two side bend tests for wall thickness above 12.7 mm
- Machined to remove the weld reinforcement.

Acceptance criteria shall be as per [API SPEC 5LC](#).

6.5 Charpy V-notch tests

6.5.1 Test Method

For welded pipes

For pipe weld and HAZ tests, each test piece shall be etched prior to notching in order to enable proper placement of the notch.

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Specimen shall:

- Not be flattened
- Be sampled at 2mm from pipe OD with, for each set
- Notch location at Weld centerline (WM), Fusion line (50% WM / 50% HAZ) and Fusion line +2.

And above scheme repeated:

- For WT > 25 mm: at 2 mm from pipe ID
- For double sided welds: at mid thickness.

Seamless pipes

Specimens shall:

- Be sampled at mid-thickness
- For pipe with WT ≥ 25 mm: be sampled 2 mm from OD and 2 mm from ID
- For pipe with WT > 35 mm: be sampled 2 mm from OD, 2 mm from ID and at mid wall thickness
- Not be flattened.

The required impact test temperature (or so-called routine test temperature) shall comply with Table 4 and in no case be above -20°C even if minimum design temperature and table 4 results in higher test temperature.

Table 4 - Charpy V-notch test temperature

Nominal Wall thickness (mm)	Test temperature
$t \leq 20$	$T = T_{min}$
$20 < t \leq 40$	$T = T_{min} - 10^{\circ}\text{C}$
$t > 40$	To be agreed

6.5.2 Acceptance criteria

Acceptance criteria for full size specimens shall be as per Table 5.

Table 5 - Transverse impact energy Charpy-V impact test

Grade	Minimum average for 3 specimens joules	Minimum single value joules
LC65-22Cr DX	70	50
LC65-25Cr SDX	70	50

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Acceptance criteria in the longitudinal direction shall be at least 50% higher than the values required in the transverse direction.

If sub-size test specimens are found necessary, to the satisfaction of Company, absorbed energy figures required shall be those for full size specimens multiplied by the corresponding factors given in Table 6.

Table 6 - Subsize specimen: multiplying factor

Specimen (mm)	Multiplying factor
10 x 10	1
10 x 7.5	5/6
10 x 6.7	7/9
10 x 5	2/3

Impact tests with values below 70J shall be examined for the presence of third phase precipitates.

A report shall be prepared and supplied to Company for review.

6.6 Macrography

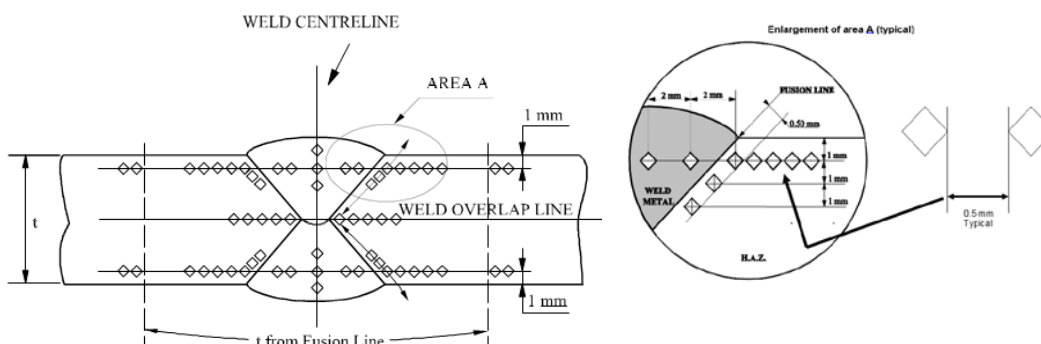
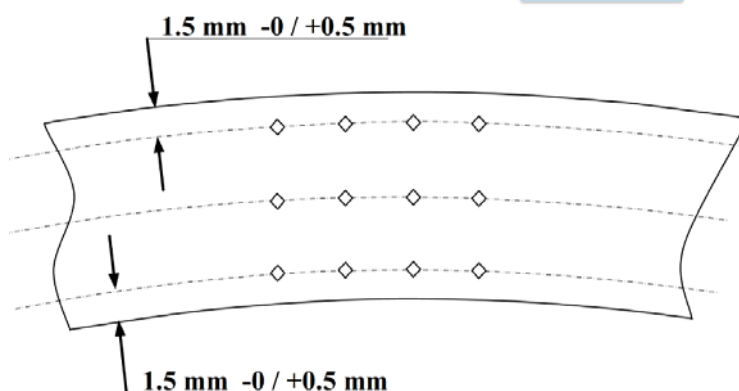
Specimens shall be polished, etched and examined at magnification of x20 minimum.

For welded pipes, the weld cross-section shall be examined to ensure that weld profile is satisfactory (refer section 10.2.3).

6.7 Hardness test

6.7.1 Test Method

A Vickers hardness survey shall be carried out on each macro section using a 5 or 10 kg load in accordance with Figure 1 and Figure 2.

Figure 1 - Weld seam hardness indent location

Figure 2 - Base material hardness indent location


6.7.2 Acceptance criteria

No individual hardness value shall exceed requirement of Table 7.

Table 7 - Hardness values with through wall test locations

Grade	HV
LC65-22Cr DX	290
LC65-25Cr SDX	330