



Exploration & Production

GENERAL SPECIFICATION

PIPELINES - RISERS

GS EP PLR 212

**Fabrication of longitudinally submerged arc welded
pipes for pipelines
(mild, intermediate and severe sour service)**

09	10/2009	General review (API Spec 5L - ISO 3183 / DNV-OS-F101)
08	10/2008	Revised § 9.4.1.1.b / § 9.5.5 / § 9.5.10 / Appendix 2 & 4
07	10/2007	General review
06	10/2006	General review
05	10/2005	Addition of "EP" root to GS identification
04	10/2004	Revised § 4, 6.1.6, 6.4.4, 7.1.2, 7.5, 7.6, 7.10.2, 7.10.3, 9.3.2, 9.5.4, 9.5.5, 9.6, 9.7, 14.2, Appendix 7, 12, 13
03	11/2003	Up-dating - Change of Group name and logo
02	10/2002	Updating for H ₂ S corrosion tests
01	11/2001	Up-dating
00	06/2001	First issue
Rev.	Date	Notes

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1. Scope

This specification defines the COMPANY's general requirements for the manufacture and supply of bare carbon steel pipes to be used in the construction of onshore or underwater pipelines, for crude oil, gas, multiphase or condensate effluents, operating in "Mild Sour service, Intermediate Sour Service" or "Severe Sour Service" (i.e. corresponding respectively to areas 1, 2 and 3 in design specification **GS EP COR 170**).

It applies to longitudinally Submerged Arc Welded pipes (SAWL) in Grade L290M L450M of **API Spec 5L / ISO 3183 (modified)** Specification, manufactured by the UOE process, the Press Bending Process or the Roll Bending process. It takes also into consideration **DNV-OSF-101** requirements (see Appendix 14).

This Specification shall **always** be used in conjunction with a Project Particular Specification (PPS) detailing the additional tests and requirements or the possible modifications to the present specification, based on the particular design conditions of the Pipeline Project (see section 4 of this specification).

Requirements are also provided in this specification for line pipes with Wall Thickness requiring a Post Weld Heat Treatment (PWHT), where the properties of Base Steel and Weld are to be ascertained after the PWHT is made.

No deviation from the requirements stated in the present specification shall be permitted unless prior written approval has been obtained from the DGEP/TDO/TEC/PLR COMPANY department, the only authorised authority. Refer to Section 17 of this specification.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

The order of precedence of the applicable documents shall be:

- The Purchase Order/Requisition
- The Project Particular Specification (PPS)
- The present General Specification
- The codes and standards in reference.

Applicable Codes and Standards which are to be used in conjunction with this specification are stated in paragraphs hereafter.

Unless otherwise specifically indicated in writing by the COMPANY, the SUPPLIER shall work in accordance with the requirements specified herein and the applicable requirements of the latest editions at date of Contract award of the referenced Codes and Standards, whenever requested in the present specification.

Where this specification states no overriding requirements, the referenced Codes and Standards shall apply in full.

Standards equivalent to those referred to herein shall not be substituted without the written approval of the COMPANY. Approval of equivalent standards will not, in any way, remove

responsibility from the SUPPLIER to meet the requirements of the Standards referred to and amended herein, in the event of conflict.

The SUPPLIER shall equip himself with copies of all the reference specifications referred to in this specification and shall make them readily available to all fabrication, testing and inspection personnel involved on the work.

Note: The specification **GS EP COR 170** is mentioned herein only as a background to the definition of the types of sour services (i.e. Mild Sour service, Intermediate Sour Service or Severe Sour Service) and corresponding “areas” on graph of the said specification (i.e. area 1, 2 or 3).

Standards

Reference	Title
ASTM A 370	Mechanical Testing of Steel Products
ASTM A 578	Straight-beam ultrasonic examination of plain and clad steel plates of special application
ASTM E 23	Notched Bar Impact Testing of Metallic Materials
ASTM E 112	Estimating the Average Grain Size of Metals
ASTM E 384	Test Method for Micro hardness of Materials
ASTM E 709	Magnetic Particle Examination
ASTM E 747	Test Method for Controlling Quality of Radiographic Examination Using Wire Penetrameters
ASTM G 39	Practice for Preparation and Use of Bent-Beam Stress-Corrosion Tests Specimens
BS 5996	Methods for Ultrasonic testing and Specifying Quality Grades of Ferritic Steel Plate
EN 473	Qualification and certification of non-destructive testing personnel
EN 462-1	Image Quality of Radiographs
EN 10204	Types of inspection documents
ISO 148	Charpy impact test (V-notch)
ISO 643	Acier - Détermination micrographique de la grosseur de grain apparente
ISO 1027	Radiographic Image Quality Indicators for non-destructive testing. Principles and identification
ISO 6507	Hardness test - Vickers test - Part 1: HV5 to HV10
ISO 7539	Corrosion of Metals and Alloys - Stress Corrosion Testing
ISO 12094	Welded steel tubes for pressure purpose. Ultrasonic testing for the detection of laminar imperfections in the strips/plates used for the manufacture of welded tubes

Reference	Title
ISO 12096	Radiographic testing of longitudinal and spiral welds for the detection of imperfections
ISO 15156-2	Petroleum and natural gas industries - Materials for use in H ₂ S-containing environments in oil and gas production - Part 2: cracking-resistant carbon and low alloy steels, and the use of cast irons
ISO 19232-1	Non-destructive testing - Image quality of radiographs - Part 1: Image quality indicators (wire type)
ISO/TS 29001	Quality systems: Model for quality assurance in production, installation and servicing

Professional Documents

Reference	Title
API Spec 5L / ISO 3183 (modified)	Specification for Line Pipe
API RP 5L1	Railroad Transportation of Line Pipe
API RP 5L3	Drop-Weight Tear Test on line pipe
API RP 5LW	Transportation of Line pipe on Barges and Marine Vessels
EFC Publication no. 16	Guidelines on materials requirements for carbon and low alloy steels for H ₂ S - containing environments in oil and gas production
NACE MR0175	Sulphide Stress Cracking resistant metallic material for oil field equipment
NACE TM0177	Testing of Metals for Resistance to Sulphide Stress Cracking at ambient Temperatures
NACE TM0284	Evaluation of Pipeline Steel for Resistance to Stepwise Cracking

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
ASME, Section V	Boiler and Pressure Vessel Code. Non-destructive Examination
ASME, Section II	Boiler and Pressure Vessel Code
ANSI/AWS A5.1	Welding consumables
DNV-OS-F101	Offshore Standard - Submarine Pipeline Systems

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS EP COR 170	Materials for sour service (upstream applications). Specification for design
GS EP PLR 231	Induction bends for pipelines (mild, intermediate and severe sour service)

3. General

3.1 Definitions

- Inspector** The COMPANY's representatives or members from an Inspection Agency duly appointed by the COMPANY and thus notified to the SUPPLIER shall be referred to herein as the "Inspector".
- Mill** The plants, mills, workshops, laboratories or other locations where the fabrication, inspection and testing of steel and pipes are to be performed complete or in part, shall be referred to herein as the "Mill".
- Contract** The Purchase Order together with all material requisitions, specifications, etc., issued by the COMPANY and/or purchaser and attached to the contract or the purchase order shall be referred to herein as the "Contract".
- Approval** Authorisation in writing given by the COMPANY to the SUPPLIER on a procedure or to proceed with the performance of a specific part of the work without releasing in any way the SUPPLIER from any of its obligations to conform with the technical specifications, requisitions, etc. "approve", "approved" and "approval" shall be construed accordingly.
- PPS** Used to designate the Project Particular Specification.

3.2 Quality Assurance/Quality Control

1. The SUPPLIER shall operate a Quality Assurance system in accordance with [ISO/TS 29001](#), approved by a recognized authority. The Quality Assurance Manual shall be submitted to COMPANY.
2. Three weeks prior to commencement of pipe manufacture, the SUPPLIER shall prepare and submit to COMPANY a written Quality Control Plan which describes the inspections to be performed during the supply of steel, plates and pipes. The Quality Control Plan shall set forth "witness", "hold", "review" and "monitor" points.
3. Just before production starting, mill QA Representative accompanied by Inspector shall check at every production and inspection station, that the relevant working instructions and procedures are available, complete, conform to the procedures agreed by COMPANY or to COMPANY specification requirements. A report shall be issued by supplier, signed by Inspector and enclosed with the final dossier.

4. Project Particular Specification (PPS)

The following information shall be provided in the PPS:

1. Steel grade
2. Pipe nominal dimension in mm (O.D. x W.T.)
3. The sour service severity and pipeline effluent to clarify the H₂S test conditions (see Appendix 15 and Appendix 16)
4. The type(s) of pipeline(s) onshore or offshore
5. If it is a gas pipeline (applicable particular requirements for CVN in table 4 Appendix 2)
6. If Appendix 14 of [DNV-OS-F101](#) "Particular Requirements" is applicable
7. If Appendix 14 of [DNV-OS-F101](#) "Supplementary Requirement" F, P, D or U is/are applicable
8. If Press Bending process or Roll Bending process is accepted (see § 7.2)
9. If pipes shorter than 11.60 metres are acceptable (where necessary (see § 7.9.6)
10. The required length for welds reinforcement grinding (ID/OD)° for girth welding and AUT application (if any)
11. The required length for cut back coating
12. Routine impact test temperature (see § 9.5.4)
13. Routine test temperature of DWTT (see § 9.5.7)
14. If welding tests results on similar pipe materials are required (see § 14.2)
15. If § 7.9.4 b is applicable (when automatic UT on girth welds is foreseen).
16. If histograms are required (see § 14.3.a)
17. Number of originals and copies of Mill certificates and final production report (see § 14.3.b)
18. If PWHT test is required (see Appendix 7, Item 11)
19. If weldability tests are required (see § 7.1 and Appendix 7, Item 12)
20. If coloured painted band on pipe is maintained or is pending (see Section 11)

21. If a bar code system is required or, otherwise, acceptable (see Section 11)
22. If bevel protectors are confirmed (where necessary) (see Section 11)
23. If spare bend mother pipes for contingency are to be added to bend order
24. The COMPANY/purchaser inspection scope.

The PPS shall include the pipeline Data Sheet, if it is not included elsewhere in any other project specification.

Before the mass production starts, (usually after the pre-inspection meeting), the PPS shall be revised for including all the particular production, inspection... topics/qualifications mutually agreed by both Mill and COMPANY. Any further technical agreement, modification, major points, that occur during the production progress shall be reported in the PPS by Inspector.

5. Inspection by the COMPANY

1. All procedures shall have prior approval of DGEP/TDO/TEC/PLR COMPANY department. All qualification tests shall take place under the supervision of the Inspector.
2. The SUPPLIER shall notify the 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.
3. The SUPPLIER shall ensure that the Inspector has full and free access to all parts of the Mill during all fabrication and inspection stages.
4. At steel making mills, plate rolling mills and pipe mills: offices, workshops, storage yards etc., information on paper and/or in computers (procedures, working instructions, data, records, tracking system, etc.) concerning the order manufacturing and inspection, shall be made fully available and comprehensible to Inspector reading. 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.
5. It shall be made available in the inspector office, a free access to the mill computerised system:
 - Tracking system of production and inspection
 - All data and results of mechanical tests, NDE results
 - Plate input, pipe output, rejections status with causes, repairs
 - Any other information considered pertinent by the inspector for his monitoring.

Computer, software environment compatible with the mill software, software interface where necessary for data exploitation with EXCEL shall be made available by the Supplier. The Inspector shall be provided with equipments for sending/receiving faxes, communicating through @mails and high speed Internet access.

6. The Inspector shall ensure that materials and pipes are fabricated in accordance with all the specified requirements and COMPANY's approved procedures.
7. Inspection by the Inspector shall be carried out during pipe production in order to avoid any special or additional handling. Inspection will be made in such a manner to avoid delay in pipe production insofar as the pipes which are presented to him meet the specified requirements.

8. The Inspector shall finalise his inspection by the application of a special stamp, when so previously agreed) on the accepted pipes. Die stamping is permitted only on the bevel surface.
9. The Inspector shall notify the COMPANY without delay of any difficulty, irregularity, problem or delay likely to occur during pipe production.
10. The COMPANY reserves the right to re-check tests carried out by the SUPPLIER. For this purpose, the COMPANY may request the delivery of samples or specimens for analyse in an independent laboratory chosen by the COMPANY.

6. Steel making, Slab continuous casting and Plate manufacture

6.1 General requirements

- 6.1.1 Accelerated cooling of plates shall be performed at a controlled temperature higher than AR3.
- 6.1.2 The SUPPLIER shall give full details about Mill control of sequential heats.
- 6.1.3 Macro-etching or sulphur prints shall be carried out on slabs (or plates) at a frequency of once per casting sequence with a minimum of once per shift and casting sequence, on each strand. The Mill's reference chart of gradings and acceptance level will be agreed with the COMPANY.
- 6.1.4 All surfaces of the slab shall be inspected for defects and scarfing carried out if necessary. Slabs shall be correctly marked and stored to avoid any confusion between heats of steel.
- 6.1.5 The SUPPLIER shall provide the COMPANY four (4) weeks minimum before commencement of production with a detailed plate Manufacturing Procedure Specification giving full details of all the characteristics of the proposed steel plates (see details in Appendix 6 relating to pipe manufacturing procedure).
- 6.1.6 The SUPPLIER shall provide the Inspector with the temperature measurements made at all important stages of the plate fabrication flow. For TMCP steel, this shall include the temperatures and reduction ratios of the rolling steps, and temperatures at inlet and outlet of accelerated cooling facilities, with cooling rates.
- 6.1.7 The rolling records of each mother plate shall be made available for review at the plate Mill, on Inspector's request.
- 6.1.8 All calibration certificates of control devices, thermometers, recorders, shall be made available to Inspector's review prior to start the rolling campaign.
- 6.1.9 Except as otherwise previously agreed between the SUPPLIER and the COMPANY, all inspections and tests required for steel plate acceptance shall be carried out at the SUPPLIER's Mill.

6.2 Steel making

Steel shall be made to the Electric Furnace or Basic Oxygen Converter. Steel shall be fully killed and made to fine grain practice (grain size [ASTM no. 8](#) or finer according to [ISO 643 Std](#)). Grain size evaluation shall be made once at qualification of plate/pipe manufacturing procedure. Then, it shall be done only when a doubt arises about steel properties.

The steel making process shall result in the manufacture of steel plates/pipes having a high resistance to H₂S embrittlement and associated effects.

During its manufacture, the base steel shall undergo the following treatments:

- Thorough desulphurization treatment and dephosphorization treatment
- Vacuum degassing
- Specific treatment to control size, shape and distribution of oxide and manganese sulphide inclusions (e.g. calcium treatment).

6.3 Casting

Continuous casting process is required.

The casting speed shall be that proposed by the SUPPLIER and approved by the COMPANY at the bid stage. The actual production casting speed range (speed max - speed min) shall not exceed 0.1 m/min. This parameter recording shall be made available to inspector. The SUPPLIER shall give full detail about the casting sequences (number of heats, tons, scrapping lengths...).

Where continuous casting line is of fully bent type, the SUPPLIER shall provide, at the bid stage, a technical documentation concerning the implemented particular cares to overcome the weakness of a fully bent casting process in terms of inclusion segregations close to the surface and edges of plates. It shall be demonstrated that the process does not impact the final pipe quality (NDE, macro, micro, HIC reports... from past experience).

6.4 Slab / plate slitting

Slitting of mother plates and / or slabs is not permitted.

6.5 Rolling technique/Heat treatment

Plates shall be manufactured by the Thermomechanical Controlled Process, including a subsequent accelerated water cooling method.

In all cases, steel plates shall show a homogeneous very fine-grained microstructure.

The rolling parameters shall be made available at pipe mill as well for Inspector review and selection of production test pipes.

Banded structure in terms of segregated bands of carbides shall not be acceptable.

Rolling ratio shall be equal to or above 3.5.

6.6 Chemical composition

6.6.1 Chemical composition of steel and its Carbon Equivalent (CE) and Pcm, as determined on each heat and product, shall be in accordance with Tables 1 and 2 (Appendix 1). However, the ruling composition shall be that proposed by the SUPPLIER and approved by the COMPANY **at the bid stage**. The production actual composition ranges shall not be significant in terms of metallurgical influence.

6.6.2 The SUPPLIER shall carry out **ladle and product analyses** for all specified elements (plus all other intentionally added elements, when applicable). Location of sampling shall be at midway between plate edges.

6.6.3 Test frequency shall be as follows:

- Ladle analysis: one per each heat. Residual elements shall be analysed only on the first heat produced and then every 20 heats
- Product analysis: at least one per each heat. Analysis of residual elements is not required on product. Product analysis may be carried out either on plates or on pipes, at the SUPPLIER's option. However, the selected option shall be clarified by the SUPPLIER at the bid stage.

6.6.4 Recheck analyses

If any part of the product analysis fails to meet the requirements above, either the whole heat shall be rejected, or each individual plate shall be fully analysed, and all plates failing to meet the requirements shall be rejected. Samples for recheck analysis shall be taken at the same location as that specified for product analysis samples.

6.7 Mechanical Properties and Tests

6.7.1 Mechanical properties of the plates shall be measured by means of tensile and impact tests carried out transverse to the principal rolling direction.

Sampling shall be located midway between edge and centre of plate.

Charpy V notch tests shall be taken out at mid thickness.

6.4.2 Testing procedures and specimens shall be as defined under § 9.5 for finished pipes.

6.4.3 Frequency of mechanical tests: at least one tensile test and one impact test (including a set of three Charpy V-notch specimens) shall be made once per each heat.

6.4.4 Results from mechanical testing carried out on steel plates shall meet the working ranges stated by the SUPPLIER at the bid and as a minimum, the characteristics stated in Appendix 2.

6.8 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. Wall thickness checking shall be made at both the plate rolling mill and the pipe mill.

6.8.1 Visual inspection

Steel plates shall be visually examined on both surfaces.

Steel plates shall be free from surface defects such as cracks, notches, laps, tears, from foreign materials, loose mill scale and rust, and from abnormal thickness variations.

Cracks, notches and sharp bottom imperfections are unacceptable whatever their dimensions. Any other imperfection having a depth greater than 3% of the specified nominal thickness shall be considered as unacceptable defect and shall be repaired provided that the specified minimum wall thickness is maintained.

6.8.2 Thickness measurement

Plate thickness measurement shall be made once every five plates, as a minimum. Measurement shall be carried out on middle and both edges of plates, at both plate ends. This

may not apply when an automatic gauge control system including a recording is used at rolling Mill to check/measure the thickness, along the whole plate length, on both the plate axis and on one plate longitudinal edge, as a minimum. Calibration of this system shall be made minimum twice per month.

Any repair grinding shall initiate thickness checking.

Steel plate thickness measurements shall be such that the specified minimum and maximum wall thickness of finished pipes are met.

Supplier shall provide histograms with the detail of the range min/max, the mean value (M) and the standard deviation (Sd) of wall thickness records for all measurements results irrespectively of the measurement location. Sd shall be conventionally calculated as follows:

$$Sd = (w.t. \max - w.t. \min) / 6$$

Ground repair locations and marginal wall thickness values shall not be counted.

6.8.3 Ultrasonic inspection

Each steel plate shall be 100% ultrasonically inspected in accordance with the provisions stated in Appendix 3 of the present specification.

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.

The acceptance limits of imperfections are specified in Appendix 3.

6.9 Repairs

Welding repairs shall not be permitted on plates. The defects can be eliminated only by grinding provided that the plate thickness is not locally reduced below the specified minimum thickness of pipes.

A local Magnetic Particle Inspection according to [ASME Code, Section V](#), may be requested by the Inspector to ensure that the defect has been completely removed. This does not apply to cosmetic grinding areas.

Moreover, plate thickness measurement shall be carried out where a repair grinding (except cosmetic grinding) has been made.

A cosmetic grinding shall be understood as shallow imperfection which shall be corrected by using a smooth flap wheel (i.e.: Grain size disk # 100).

6.10 Plates for Bend mother pipes

6.10.1 Mother pipe manufacturing procedures

A particular attention shall be paid to mother plates manufacturing (chemical composition, rolling technique) and to mother pipes longitudinal welding in order to achieve acceptable mechanical characteristics on bends (process of bending = induction heating).

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

Any deviations to the present specification shall be submitted to the COMPANY (Refer to [GS EP PLR 231](#) for bends).

6.10.2 Particular requirement for plates

Before starting the bend mother pipe production,

Three specimens of 50 mm long in the rolling direction shall be extracted from a mother plate at 50 mm from each longitudinal edge and at mid width. The rolling direction cross sections of the specimens shall be properly polished and etched to reveal carbides. They shall be examined every 10 mm, at 5 mm from each surface and at mid wall, with a magnification of X100. The microstructure shall not exhibit banded structure in terms of carbon / carbides minor or major segregation. Three photography of typical structure shall be issued for the inspection file. The COMPANY inspector shall attend the test.

This requirement may be partially or fully waived by CY, based on the bending process review.

6.11 Marking of plates

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

The following minimum indications shall be marked on each plate:

- Purchaser's name
- Plate MANUFACTURER and Mill name
- Heat no.
- Plate no.
- Plate wall thickness x width
- Steel grade
- Order identification.

The SUPPLIER's in-house plate marking may be proposed at bid stage for steel/plate/pipe fabrication integrated plants. However, this marking shall include plate number and job identification, as a minimum, provided that traceability is demonstrated to COMPANY and included in the SUPPLIER's documentation.

6.12 Mill Certificates

The SUPPLIER shall provide the COMPANY with 3.2 Mill certificates according to [EN 10204 Std](#) for plates, together with reports of all tests and inspections carried out on plates in accordance with the present specification:

- Results of heat and product analyses (see § 6.6)
- Results of mechanical tests (see § 6.7)
- Results of visual inspection (see § 6.8.1)
- Results of thickness measurements (see § 6.8.2)
- Results of ultrasonic inspection (see § 6.8.3).

On Mill certificates, each plate shall be identified in respect of the heat and slab from which it has been produced. Mill certificates shall clearly indicate the as-delivery condition of plates (e.g. normalized, controlled rolled with accelerated cooling).

Format of Mill certificates shall be agreed prior to production between the COMPANY and the SUPPLIER.

7. Pipe manufacture

WARNING: Before starting any trial or production, Pipe Manufacturer is requested to read the Appendix 16 and to proceed, as a first priority, with the tests required in the said appendix.

7.1 General requirements

7.1.1 Pipes shall be manufactured to PSL 2 and all the requirements of **API Spec 5L**, unless otherwise indicated in the present specification, i.e. **API Spec 5L** remains applicable for all points not specifically mentioned or modified in the present specification.

7.1.2 HIC tests (as per Appendix 16) and SSC tests (as per Appendix 15) shall be required according to provisions of § 9.6 and 9.7 of this specification.

7.1.3 Weldability Tests (as per Appendix 13) are to be carried out only when so required in the PPS: refer to Appendix 7 of this specification.

7.1.4 The SUPPLIER shall guarantee the overall consistency of the pipe order (including chemical composition, dimensional, weldability, material traceability), especially if pipes are manufactured at different mills with the COMPANY's previous approval.

7.1.5 Except as otherwise previously agreed between the SUPPLIER and the COMPANY, all inspections and tests required for pipe acceptance shall be performed at the pipe manufacturing Mill.

7.2 Process of manufacture

The pipes shall be manufactured from plates by cold forming using the UOE or JCOE process (i.e. with mechanical expansion), and, when so agreed with the company at the bid stage, by the Press Bending process or the Roll Bending process, and shall have one longitudinal seam made by the automatic Submerged Arc Welding process. In all cases, the longitudinal weld seam shall include at least one pass made on the inside and at least one pass made on the outside, according to definition of **API Spec 5L**. The joint efficiency factor shall be 1.

After execution of the longitudinal seam, the run-on and run-off tabs shall be removed by flame cutting or sawing only (mechanical breaking of tabs shall be forbidden).

7.3 Cold expansion

UOE pipes shall be cold expanded at a permanent straining rate in the range 0.8% to 1.5%. The expansion ratio shall be recorded on 10 pipes minimum per shift and also on pipe used for qualification of MPS.

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

7.4 Base materials

The steel plates used in the fabrication of pipes shall meet the requirements defined under Section 6 of this specification.

7.5 Pipe Manufacturing Procedure Specification (MPS)

The SUPPLIER 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. This document will also mention the characteristics of equipment and procedures used to carry out these operations.

The proposed specification shall include, but not limited to, all pertinent informations required in Appendix 6, together with the detailed HIC procedure and SSC procedure.

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

7.6 Qualification of pipe manufacturing procedure

1. One finished pipe among the first pipes produced in each size (each diameter and each wall thickness), grade and steel source (first shift production) shall be subject to all the inspections and tests as described in Appendix 7 in order to qualify the pipe manufacturing procedure. This pipe shall be selected by the Inspector.
2. The essential variables are stated in Appendix 7, section A.
3. The SUPPLIER shall submit to the COMPANY the pipe manufacturing procedure qualification test report giving the results of all tests required by the present specification. The report shall be approved and signed by the Inspector who attended the tests.
4. The SUPPLIER is allowed to proceed with the pipe manufacture without waiting for the test results and the Inspector's approval, as long as the SUPPLIER is accepting the risk and responsibility of the consequences of any test failure, as stated here-after.
5. In case of qualification test results which do not comply with the requirements of this specification, the pipe tested as well as all preceding pipes shall be rejected. The causes of failure shall be investigated by the SUPPLIER and reported to the Inspector. Manufacture shall resume only after the procedure has been suitably revised to the satisfaction of the Inspector and after a new pipe has successfully passed all the qualification tests laid down in this specification.

7.7 Chemical properties

All pipes shall be manufactured from steel which shall have a chemical composition ensuring proper ductility, strength, toughness and weldability under all conventional welding processes and techniques used on lay barges and onshore installation works, where applicable.

The SUPPLIER shall carry out product analyses for all specified chemical elements (plus all other intentionally added elements). Those chemical compositions shall be included in Mill certificates.

Heat and Product analyses shall meet the requirements contained in Tables 1 and 2 of Appendix 1. However, the ruling composition shall be that proposed by the SUPPLIER and approved by the COMPANY at the bid stage (see § 6.6 above).

Number, type, location and frequency of tests shall be as defined under § 6.6.

7.8 Mechanical properties

The finished pipes shall meet the requirements stated in Tables 3 and 4 of Appendix 2 for tensile properties and Charpy V-notch test requirements respectively.

Number, type, location and frequency of tests shall be as defined under § 9.5.

Results of mechanical tests carried out on finished pipes shall be stated on Mill certificates.

7.9 Dimensional and weight requirements

The following requirements shall be met on each finished pipe.

Frequencies of dimensional checking, measurement and recording shall be as described in § 9.2, 9.3 and Table 5 of section 9 of present specification.

7.9.1 Diameters

a) Outside Diameter of pipe body

The tolerance shall not exceed $\pm 0.5\%$ of the specified nominal Outside Diameter, with a max. of ± 4 mm.

b) Inside Diameter of pipe ends

The tolerance on the Internal Diameter within 100 mm (4") of the pipe ends shall not exceed ± 1.6 mm from the nominal Internal Diameter defined as follows:

$$\text{Nominal ID} = \text{nominal OD} - 2 \times \text{nominal WT}$$

Above diameters shall be checked with a circumferential tape or diameter tape. However, for pipes with OD less than 20" a calliper gauge may be used provided that equipment and procedure have the prior agreement of the Inspector.

7.9.2 Out-of-roundness

a) Pipes with OD less than 20"

Out-of-roundness at the pipe ends shall be checked using an internal ring gauge of diameter 3.2 mm less than the nominal Inside Diameter. This gauge shall pass freely 100 mm into each end of the pipe when held normal to the pipe axis.

b) Pipes with OD 20" and larger

Out-of-roundness at pipe ends shall be checked using a rod gauge or a calliper gauge and measurement of actual major and minor inside diameters of pipe shall be made. The difference between maximum ID and minimum ID measured within 100 mm at each pipe end shall not exceed 0.80% of the specified nominal Inside Diameter, with a maximum of 5 mm. Nominal Inside Diameter is defined in § 7.9.1.b above.

7.9.3 Peaking

Peaking of the pipe at the weld location shall not deviate by more than 1.6 mm from the theoretical form, when measured transverse to pipe axis using Inspector approved inside and outside templates (sectors of 20° minimum) or dial gauge.

7.9.4 Wall thickness

a) Minimum wall thickness guarantee

The tolerance on wall thickness shall be -5%; +10% of the specified nominal wall thickness.

The thickness shall be checked on a circumferential area (as a minimum, at both sides of weld and at the area opposite to weld) at both ends of pipe.

Wall thickness shall be checked using a micro-meter, a limit gage, a calliper or ultrasonic.

The SUPPLIER shall guarantee the specified wall thickness along full length of finished pipe. However, random checking at mid-length of pipe shall be made by SUPPLIER at a frequency to be agreed (with a minimum of three times per shift), unless measurement and recording of plate wall thickness was made continuously at plate mill on both the strip longitudinal axis and one strip edge, as a minimum (refer to § 6.8.2 of this specification). Wall thickness print-outs shall be made available to the Inspector in that case, for review at the pipe Mill.

b) Particular requirement (for further Automatic UT on pipe laying girth welds)

When so required in the PPS and when the pipe item wall thickness Standard deviation has been found in plate mill in excess of 0.25 mm, (see § 6.8.2), the following shall apply:

- Wall thickness shall be measured and recorded on 100% of pipe ends, at 2 locations of each end: at 20 mm approx. from one weld toe and at the weld opposite side (i.e. 4 measurements on each pipe)
- Measurements shall not be carried out on ground areas
- A dial micro-meter shall be used for measurement. Its fingers (jaws) shall be sharp or round ended for a proper touch on internal pipe surface
- The accuracy of measurements and records shall be of 0.1 mm, for example, 17.2 mm, 20.6 mm
- The results shall be presented on a histogram and shall indicate the Mean value (M) and the Standard deviation (Sd).

The measured wall thickness versus the pipe numbers and end sides shall be traceable. The records shall be made available to COMPANY or pipe laying Contractor review and shall be included in the final documentation as a computer file, compatible with EXCEL.

7.9.5 Weight

Each pipe length shall be weighed individually.

The tolerance on the weight of any single length of pipe shall be -3.5%; +10% of the nominal weight.

7.9.6 Unit length

a) Pipes shall be supplied in lengths of 12.20 m $\pm$ 0.60 m with a minimum average length of 12.20 m for each item of the order.

However, when so permitted in PPS, 3% of the pipes may have an individual length between 10.00 m and 11.59 m, always providing that the average length of each item of the order is 12.20 m.

No pipes shall be shorter than 10.00 m.

The shorter pipes shall be differentiated from the other pipes by a band of a different colour at one pipe end.

- b) Jointers made by welding two pipe sections to produce the specified pipe length shall not be permitted.

7.9.7 Straightness

The deviation from a straight line (taut wire), positioned at 3 or 9 O'clock shall not exceed 1.4 mm per metre of length. Straightness shall be checked according two planes, as a minimum, displaced by 90°. One of these planes shall include the longitudinal seam.

Cold straightening is allowed provided that the resulting permanent straining does not exceed 1%.

7.9.8 Squareness of pipe ends

The pipe ends shall be cut perpendicular to the pipe longitudinal axis within 1.6 mm across any diameter. Checking shall be made either at the end facing machine or using an angle.

7.9.9 Pipe end preparation

- a) Pipes shall be furnished with both ends bevelled to an angle of 30° +5°, -0° with a root face of 1.6 mm ± 0.6 mm (1.6 mm ± 0.8 mm at weld seam area).

Bevelling shall be carried out by straight machining only. There shall be no internal taper.

- b) Any repair by grinding on the bevel edge further to machine bevelling shall be cause for full re-bevelling. However, internal burrs can be removed by filing provided that the root face is not altered to the satisfaction of the Inspector.

- c) The inside and outside weld reinforcements shall be ground flush (to -0.0 mm, +0.5 mm) with the inside contour of the pipe for a minimum distance of 100 mm from each end.

Note: Such grinding operation shall be carried out before cold expansion

7.9.10 Height of weld beads

The weld bead height above the prolongation of the original surface of the pipe shall be within 0.5 mm and 3.0 mm, whatever the wall thickness. Weld concavity is not permitted.

7.9.11 Offset of plate edges

The maximum radial offset shall be 10% of the nominal wall thickness of the pipe, with a maximum of 1.5 mm.

7.9.12 Bulges, dents and flat areas

On the pipe body, deviations from the original contour of the pipe shall not exceed 3 mm depth, nor shall they extend in any direction greater than 1/4 of the diameter of the pipe. Any sharp bottom deformations shall be unacceptable.

7.10 Welding

7.10.1 Pipe mill Welding Engineer

A Welding Engineer appointed to the mill welding is required. He will carry the responsibility for the welding quality management. He will be the COMPANY/Inspector interlocutor for all welding matters. The Welding Engineer shall be available at any time in or close to the workshop. His name shall be stated in the "Pipe Manufacturing Procedure Specification" (see § 14.2 and item 24).

7.10.2 Welding processes

The welding process for longitudinal seam shall be confined to the automatic Submerged Arc Welding (SAW) process.

Gas Metal Arc Welding (GMAW) process may be used for tack-welding only, provided that the weld is completely re-melted by the Submerged Arc Welding process. Refer to § 7.10.6 of this specification.

Weld repairs shall be carried out by SAW process or manual Shielded Metal Arc Welding (SMAW) process using extra-low hydrogen electrodes.

Each welding procedure shall be fully detailed in a Welding Procedure Specification (WPS) form previously approved by the Inspector.

7.10.3 Welding consumables

- a) The weld deposits obtained from the consumables shall satisfy the impact toughness and hardness requirements of this specification and shall have tensile properties that are equal to or slightly higher than those of the base metal. YS and TS of weld metal shall not exceed the specified maximum YS and TS of base metal shown in Table 3 of Appendix 2. YS to TS ratio of weld metal shall be reported for information only.
- b) The chemical analysis of weld deposit shall not include more than 1.0% Nickel and 0.5% Molybdenum.
- c) All welding consumables shall conform to [ASME, Section II Part C \(AWS\)](#) or approved equivalent. MANUFACTURER's data sheets shall be supplied to the COMPANY for information.
- d) Each heat, lot (or so called batch herein) of consumables shall be subject to inspection and approval by the Inspector. 3.2 Mill test certificates from consumable MANUFACTURERS showing test results actually obtained on the said lot shall be submitted to the Inspector.

The lot and the level of testing are specified as per [AWS A5.01-93](#) as follows:

- Covered electrodes: class C5
- Bare solid electrodes and rods: class S3
- Flux cored electrodes and metal cored electrodes and rods: class T3
- Flux for submerged arc welding: class F2.

The level of testing shall be schedule I as a minimum.

For SAW flux, additional diffusible hydrogen test and/or moisture test shall be required as per Appendix 5 of the present specification when "Method B" is proposed.

- e) Coated electrodes shall be of the extra low hydrogen type (i.e. maximum specified hydrogen content of 5 ml per 100 grams of Weld Metal).
- f) Low hydrogen coated electrodes and welding fluxes shall be supplied in moisture guaranteed proof containers and used according to the recommendations of their MANUFACTURERS. If there are no written recommendations available from the MANUFACTURERS of consumables the following instructions shall be applied:
 - Low hydrogen coated electrodes conforming to ANSI/AWS A5.1 shall be oven dried for at least two hours between 350°C and 430°C. A lower temperature for a longer holding time is not acceptable. Immediately upon withdrawal from their hermetically sealed container or drying oven, the electrodes shall be kept in a holding oven at approximately 100°C before use. Electrodes withdrawn from the holding oven shall be used within two hours after withdrawal. If unused they shall be re-dried as above
 - Fluxes procurement, packing, storage and use shall conform to the Appendix 5 of the present specification
 - The SUPPLIER shall verify the grain-size of the flux at the beginning of each working shift. The recorded grain-size shall comply with the recommendation of flux VENDOR. Should any deviation be recorded, the flux shall be rejected.
- g) The SUPPLIER's consumables procedure for storing, handling, drying, recycling and traceability shall be approved by the Inspector before commencement of production welding.
- h) All welding consumable certificates shall be submitted to the Inspector. The welding consumable Manufacturer's test certificates for each batch and lot of consumables shall be made available for that purpose. These documents shall certify that the consumables meet the requirements of the relevant standards for classification and grade and testing as stated in the above § c).

7.10.4 Welding procedure qualifications

a) Longitudinal weld seam

The welding procedure for longitudinal weld shall be qualified together with the pipe manufacturing procedure (see § 7.6 and Appendix 7) based on the submitted WPS. Previously qualified welding procedures are not acceptable.

b) Repair welding

Repairs due to welding process failures (i/e: "blow-through" during tack-welding, "flux stop", "wire stop" during SAW, etc.) inducing Base metal repair, are not permitted.

Unless otherwise agreed with the COMPANY, two repair types shall be qualified by tests on a pipe of the order:

- One partial repair (minimum of 2/3 thickness repair) simulating a defect located on Fusion Line, and
- One shallow inside of pipe repair with two weld passes minimum simulating a defect located at weld toe.

Where welding from inside of pipe is not intended by the SUPPLIER, nor practicable, nor accepted by the COMPANY, then a through thickness repair simulating a defect centred in Weld Metal axis shall also be required.

All repairs shall include a minimum preheating of 100°C, unless the qualification test has shown that a higher temperature is necessary.

Each welding repair shall be qualified on a pipe section under realistic conditions to the satisfaction of the Inspector, in accordance with Appendix 12.

c) SSC tests

SSC tests shall be carried out on all qualification test welds (main welds and repair welds) according to test procedure stated in Appendix 15 of present General Specification.

For all kinds of test weld repairs, SSC tests shall be carried out at the two following locations: one test at repair start and one test at middle length of repair (refer to Appendix 12). On partial repair and on through thickness repair, if any, specimen shall be located at root. On all repairs (including shallow repair), specimen ID side shall be in tension.

7.10.5 Qualification of manual welders

All manual welders shall be qualified as follows:

- Welders who have performed the above (§ 7.10.4.b) satisfactory welding procedure qualification tests are thereby qualified.
- Other welders shall be qualified in accordance with Appendix 12 by visual and radiographic examinations and four side bend tests at locations selected by the Inspector:

7.10.6 Production welding

7.10.6.1 Welding conditions

a) Pipe cleanliness

Any lubricant and contamination on the weld bevel or the surrounding areas shall be removed before making the seam welds (tack weld and SAW weld) (as per [DNV-OS-F101](#) sec. 7 B321). Weld bevel shall be free from any water or damp.

b) Welding parameters

The welding conditions used for the longitudinal weld and repair welds shall not depart from those of the related procedure qualification test.

However, the following variations shall be acceptable, always providing that variation of welding heat input shall be within $\pm 10\%$:

- Amperage: $\pm 10\%$
- Voltage: $\pm 7\%$ ($\pm 10\%$ for manual repairs)
- Travel speed: $\pm 10\%$ for automatic welding ($\pm 15\%$ for manual repairs)
- Preheating/interpass temperature: -0°C , $+50^{\circ}\text{C}$ (provided that max. interpass temperature of 280°C is not exceeded).
- **Note:** The integration time of the parameter display (and/or recorded) mean value shall not exceed one second.

c) Flux coverage

Specific attention shall be paid to flux coverage of all arcs, especially to the last one in case of multi-wires process. Visible arc shall not be permitted

d) Tack weld repairs

The height of tack weld made by automatic welding, if any, shall be indicated on WPS. Any 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.

7.10.6.2 Weld seam geometric characteristics

a) Weld concavity at pipe ends

Supplier shall take cares of run on/off tab length, suitable welding speed, effective welding start and stop distance from pipe ends, straightening of tabs before external welding where necessary, welding wire sequenced stop/start, etc., in order to avoid any weld shrinkage concavity at pipe ends. The welding end **concavity** shall be fully located in the tab.

Internal and external welds at pipe ends shall be inspected before any grinding. Where a concavity is found at pipe end, and even if the further grinding can eliminate the concavity, the concerned end shall be cut off.

b) Out-Of-Line Weld Bead

The offset between the centrelines of the internal and external weld beads shall not exceed 3 mm. The narrowest point of the weld bead cross-section shall not be less than one-fourth (1/4) of the nominal wall thickness of the pipe with a minimum of 4 mm (see Figures in Appendix 8). Checking for bead misalignment shall be performed on specimens prepared for hardness test (see § 9.5.5 of this specification).

c) Drift of welding groove after forming (Welding angle)

The welding angle due to the groove drift may cause a lack of interpenetration (see figures in Appendix 8). The drift angle is affecting the Automatic Ultrasonic Testing (AUT) efficiency as well when the AUT weld seam tracking is also not based on pipe rotation.

When the seam tracking system of welding is not based on pipe rotation the special inspection requirement of § 9.3.2.c shall apply.

d) Weld toe profile

The weld toe shall merge smoothly onto the base material. The connection angle shall not exceed 20° (refer to figure in Appendix 8 and § 9.5.5 of this specification).

8. Mill hydrostatic testing

1. The required test pressure shall be computed using the following formula which includes a fiber stress of 90% of the Minimum Specified Yield Strength of the pipe material:

$$P = \frac{20 \times 0.90 \times S \times t}{D}$$

- P Hydrostatic test pressure in bar
S Minimum Specified Yield Strength in N/mm² or MPa
t Specified nominal wall thickness in mm
D Nominal outside diameter in mm

When **DNV-OSF-101** is applicable, formula of section 7 § E102 shall apply to determine the test pressure.

2. When sealing against the end face of the pipe is made by means of a ram which produces a compressive longitudinal stress, an appropriate calculation may be produced by the SUPPLIER to prove that the actual hoop stress in the tested pipe is equal to 90% min. of MSYS as stated in the above formula. The RAM pressure system shall be designed such that the RAM pressure increases progressively and proportionally to the pipe internal pressure.
3. The test pressure shall be held for duration of not less than 10 seconds for each pipe.
The test configuration shall permit bleeding of trapped air prior of pressurisation of pipe. The equipment shall be capable of registering a pressure drop of minimum 2% of the applied pressure (**DNV-OS-F101**, sec. 7, E107).
4. The pipe positioning procedure shall be such that the weld seam can be seen by the operator during testing.
5. A certificate of calibration established less than 12 months before the pipe fabrication, by a recognised authority, shall be provided by the SUPPLIER for the master gauge. However, the pressure gauge and recorder shall be calibrated in-house against the said master gauge before start of production, and at least once per week thereafter. The pressure gauge and the recorder pressure measurement mechanisms shall be independent.
6. Mill hydrostatic test pressure prints shall show clearly the pipe number, the date of test, the applied test pressure and the test duration for each pipe. Prints shall be available to the Inspector for conformance check at the Mill.
7. A Mill hydrostatic test certificate of compliance giving Mill hydrostatic test requirements (test pressure and duration) shall be established by the SUPPLIER and furnished to the COMPANY. The SUPPLIER shall certify that every length of pipes has been tested without any leak or sweat in accordance with the requirements of this specification.

9. Inspection and testing

9.1 General requirements

1. The production preventive measures and the inspections required in the present specification are stated as a minimum. The SUPPLIER shall bear the responsibility for the conformity of its

supply to all requirements of this specification in terms of characteristics and soundness. He shall, for this purpose, take all measures such as additional inspection, metallurgical investigations...when, as an expert, he judges necessary to extend the scope for the required pipe quality and for what is implicit for the pipe quality. Moreover, the SUPPLIER shall make use of suitable means, devices and qualified personnel, enabling him to ensure permanent and effective control at each stage of manufacture.

2. The SUPPLIER shall develop a Quality Control Plan (refer to § 3.2 of this specification) for approval by the COMPANY and shall carry out all inspections and tests required by this specification.
3. The SUPPLIER shall develop, in the pipe mill, a fast-track feed back system between the inspection and the production for the occurrence of abnormality, progressive drift and recurrent defects, in order to implement immediate corrective actions.
4. All inspections carried out by the SUPPLIER during pipe manufacture shall form the subject of constantly updated reports. These reports shall be available for consultation by the Inspector at any time.
5. If during the main production, more than 7% of the pipes are rejected in any day's production or re-routed for repairs or re-processing, then the Inspector shall have the right to ask the SUPPLIER to increase his Quality Control Programme to an appropriate level and to maintain it until the causes of defective quality are identified and eliminated. Where above rate attains 10%, the Inspector may require the main production to be stopped. In such a case COMPANY may require 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 Supplier (see also §7.1.1 above). The rest of production shall be put on hold until result of investigations and COMPANY acceptance
6. Only pipes fully meeting the requirements of this specification shall be presented to the Inspector for final acceptance.
7. The SUPPLIER shall provide office space and inspection facilities, as required by the Inspector, in the Mill. Free access shall be allowed to him at all production and inspection stations at all times during manufacture and testing. A suitable working area shall be reserved for him at the end of the production line or at any other agreed location so that he can carry out his own inspections on the finished pipes.
8. See also the provisions of section 5 of this specification, for information.
9. All finished pipes shall be submitted to production tests and inspections as defined in the following paragraphs.
10. All visual inspection, dimensional inspection and Non-Destructive inspection procedures shall have prior approval of the inspector and shall be subject to qualification tests prior to their use in production. Further to acceptable results, qualification records shall be established by the supplier, duly signed by the Inspector and filed in the final documentation.
11. **Note:** A "Qualification" shall consist at the very start of production, to implement the CY approved written procedure in the presence of the mill QA/QC representative and of the Inspector. The Inspector and the mill QA/QC shall check that the working instructions are complete and correct, that the procedure has been implemented as it is written, that the environment (e.g. lighting, access way) is suitable, that tools, equipment are convenient, that the procedure is fully efficient for the inspection purpose in view of specification requirements, that recording and traceability are satisfactory, etc.

12. All Non-Destructive inspection personnel shall be properly certified according to [CSWIP](#) scheme or [EN 473 Std](#), or equivalent COMPANY approved Std ([ASNT](#) "in-house" qualification is not acceptable, only qualification by a third party may be accepted), and shall have also been approved by the Inspector before any involvement on the order. NDT operators shall be certified level 2, as a minimum. The SUPPLIER shall supply the Inspector with a list of inspection personnel working on the job, showing their scope of qualification and date(s) of qualifications.

9.2 Dimensional inspection

All specified dimensions (as per § 7.9) shall be checked measured and recorded to the frequencies shown in Table 5, of present section, unless otherwise agreed at the bid stage.

Measurement and recording of all stated dimensions shall be required on every Press Bending or Roll Bending pipes.

Additional wall thickness measurements shall be carried out on ground areas (see section 10 of this specification), except for cosmetic grinding.

Note on definitions:

- "Checking" means that inspection consists to verify that the said dimension is within the permitted tolerances (exact dimension is not required) e.g. go-no go gauge check
- "Measurement" means that a real measurement is carried out and a precise figure is obtained as a result of it
- "Recording" means that the value of actual measurement as above is recorded and filed.

9.3 Visual examination/Workmanship

9.3.1 Visual examination

A visual examination of the total inside and outside pipe surfaces including the weld seam shall be carried out on each pipe. For pipe of 24" OD and larger, the inside inspection will be made by "crawling" through the pipe. Reference shall be made to Table 5 of present section.

The bevels shall be smooth and free from tool marks.

9.3.2 Workmanship and defects

The standards of acceptance shall conform to [API Spec 5L / ISO 3183](#), clause 9.10, with modifications as follows: The provisions of Table 5 of present section shall apply.

a) Bulges, dents and flat areas

Refer to § 7.9.12 of this specification.

b) Offset of Plate Edges

Refer to § 7.9.11 of this specification.

c) Lack of Weld Penetration

When the special inspection requirement of § 7.10.6.2.c) is applicable, the weld penetration shall be visually checked at both pipe ends on every pipe by chemical etching on the machined weld sections. The narrowest point of the weld bead cross-section shall not be less than 2 mm (see Figure in Appendix 8).

d) Height of Weld Beads

Refer to § 7.9.10 of this specification.

e) Hard spots

The hardness is limited to 250 HV5 (or 22 HRC) to all parts of the pipe.

f) Cracks and leaks

All cracks, sweats and leaks are not acceptable. They shall be clearly marked and the pipe set aside for investigation by the SUPPLIER and the Inspector.

The SUPPLIER shall determine the cause of cracks with reporting to the Inspector. Based on the findings, the SUPPLIER shall then define and maintain all appropriate measures to avoid occurrence of cracks, to the satisfaction of the Inspector.

According to the origin of cracks the Inspector may require an increase of inspection from the SUPPLIER's quality control.

g) Laminations

Pipe bevels showing linear indications exceeding 3 mm shall be cut back.

h) Arc Burns

Repair by welding is not permitted.

i) Undercuts

Undercuts with a max. depth of 0.2 mm are acceptable in any length.

Undercuts with a max. depth of 0.8 mm and not exceeding 5% of the wall thickness are acceptable provided that:

- Their length is less than one-half of the wall thickness.
- There is no more than two such undercuts in any 300 mm of weld length.

Undercuts which are coincident at inside and outside weld are not permitted.

Undercuts exceeding the above limits shall be removed by grinding or repaired by welding.

Undercut repairs after pipe expansion is not accepted.

j) Surface condition of pipe

Pipes shall be free from defects and shall have a workmanlike finish. Pipe surface shall be substantially free from mill scales, scabs, pits, scores and laps, as well as unrepaired tears, raised slivers, bristles of steel, sharp notches, scratches or mechanical marks.

All those defects shall be removed by grinding before expansion and hydrotest. Thickness measurements shall be made on all areas where grinding has been carried out, except for cosmetic guiding.

A cosmetic grinding shall be understood as shallow imperfection which shall be corrected by using a smooth flap wheel (i/e: Grain size disk # 100).

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

k) Other Defects

- All sharp-bottom imperfections shall be considered as unacceptable defects, regardless of depth
- Any imperfection showing a depth exceeding 5% of the specified nominal wall thickness shall be considered as unacceptable.

Table 5 - Frequencies of visual and dimensional inspections

Inspection Items (3)	Mini. frequency Check (2)	Mini. frequency Measurement/Recording (1) (2)
• WT (ends)	All pipes	All or 20/shift (4)
• I.D. (ends)	All pipes	20/shift
• Inside O.O.R (ends)		
• Unit length	All pipes	All pipes
• Unit weight		
• Peaking (ends)	All pipes	20/shift
• Peaking (mid-length)	20/shift	5/shift
• O.D. (ends)		
• O.D. (body)		
• Straightness	5/shift	5/shift
• Squareness (ends)		
• Residual magnetism		
• Bevel		
• Height of weld bead	20/shift	5/shift
• Offset of plate edges		
• Weld penetration (ends)	All pipes (etching +visual)	5/shift
• Bulges, dents, flat areas	All pipes (visual)	All pipes with anomaly
• Surface condition (inside, outside) (arc burns, undercuts, surface imperfections, etc.)	All pipes (visual)	UT on ground areas (except for cosmetic grinding)
(1) Measurement/recording frequency shall be increased in mutual agreement with the COMPANY when dimensional histograms are required. (2) Definitions of “checking”, “measurement” and “recording” are stated in § 9.2. (3) All inspection items contained in above table shall be checked on each Press Bending pipes or Roll Bending pipe. (4) Refer to § 7.9.4.		