



Exploration & Production

## GENERAL SPECIFICATION

### PIPELINES - RISERS

#### GS EP PLR 421

**Site welding of carbon steel pipelines to API 1104  
(mild, intermediate and severe sour service)**

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|------|---------|--------------------------------------------------------------------------------------------------|
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## 1. Scope

This specification defines the Company general requirements for the field welding and inspection of transmission pipelines operating in Mild, Intermediate or Severe Sour Service as defined in specification **GS EP COR 170**.

It applies to butt welding (including tie-ins), fillet welding and socket welding of line pipes, bends, flanges, branch outlet fittings and other fittings in carbon steel and low alloy steel, with a minimum specified yield strength not exceeding 65,000 psi (448 MPa), during onshore or offshore installation of the said pipelines.

Branches made of pipes directly welded to main pipeline are not allowed (see § 10.9 of this specification).

Pipe anchoring system (anchor flanges, etc.) shall consist of a single forged body as such it shall have the same internal diameter as that of the connecting line (Riser, FLET, ITA, etc.).

Due to the presence of sour effluent, all welds shall have a good resistance to any kinds of H<sub>2</sub>S embrittlement.

This specification shall be used in conjunction with a Project Particular Specification (PPS) to be made for purpose detailing the additional tests and requirements or the possible modifications to the present specification, based on the special design conditions of the pipeline project.

## 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 work shall satisfy the requirements of **ANSI B 31.4** or **ANSI B 31.8**, where applicable.

Welding shall be carried-out to **API 1104** and the amendments contained in this specification.

Should omissions or ambiguity or incorrect information exist, they shall be notified as soon as possible by Contractor to Company, and Company shall have the right of final decision.

All codes, specifications, standards and other documents which are referenced in this specification are listed hereafter.

The order of precedence of the applicable documents shall be:

- The Contract
- The Project Particular Specification (PPS)
- The present General Specification
- The codes and standards in reference.

Unless otherwise specifically indicated in writing by the Company, the Contractor 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.

**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 for Special Application                                                |
| ASTM E 384     | Test Method for Micro hardness of Materials                                                                                                |
| ASTM E 709     | Magnetic particle Examination                                                                                                              |
| ASTM E 23      | Notched Bar Impact Testing of Metallic Materials                                                                                           |
| ASTM G 39      | Practice for Preparation and Use of Bent-Beam Stress Corrosion Test Specimens                                                              |
| AWS A5.01-93   | Filler Metal Procurement Guidelines                                                                                                        |
| BS EN 1435     | Non Destructive Testing of welds radiographic testing of welded joints                                                                     |
| BS 3923        | Aerospace Series - Nickel Base Alloy NI - B41203 (NiCr7Si5B3Fe3) - Filler Metal for Brazing - Powder or Paste                              |
| BS 4105        | Liquid Carbon Dioxide: Industrial                                                                                                          |
| BS 4365        | Industrial Argon                                                                                                                           |
| BS 7448        | Fracture mechanics toughness tests                                                                                                         |
| CSWIP          | Certification Scheme for Personnel                                                                                                         |
| EN 584.1       | Non destructive testing - Industrial radiographic film - Part 1: Classification of film systems for industrial radiography                 |
| EN 462.1       | Non-destructive testing. Image quality of radiographs - Part 1: Image quality indicators (wire type), determination of image quality value |
| EN 473         | General principles for qualification and certification of NDT personnel                                                                    |
| EN 1435        | Non-destructive examination of welds. Radiographic examination of welded joints                                                            |
| EN 10204       | Types of inspection documents                                                                                                              |
| ISO 1027       | Radiographic image quality indicators for non-destructive testing                                                                          |
| ISO 1106-1/2/3 | Recommended practice for radiographic examination of welded joints                                                                         |
| ISO 2504       | Radiography of welds and viewing conditions for films                                                                                      |
| ISO 5579       | Radiographic testing of metallic materials by X and gamma-rays                                                                             |
| ISO 7539       | Corrosion of Metals and Alloys - Stress Corrosion Testing                                                                                  |
| ISO/EN 10045-1 | Metallic materials. Charpy impact test - Part 1: Test method                                                                               |



| Reference    | Title                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ISO 15156-2  | Petroleum and natural gas industries - Materials for use in H <sub>2</sub> S - containing environments in oil and gas production - Part 2 : cracking-resistant carbon and low alloy steels, and the use of cast irons<br><br>Quality systems: Model for quality assurance in production, installation and servicing<br><br>Integrally Reinforced Forged Branch Outlet Fittings - Socket Welding, Threaded and Buttwelding Ends |
| ISO TS 29001 |                                                                                                                                                                                                                                                                                                                                                                                                                                |
| MSS SP 97    |                                                                                                                                                                                                                                                                                                                                                                                                                                |

### Professional Documents

| Reference             | Title                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| API 1104              | Standard for Welding Pipelines and Related Facilities<br><br>Guidelines on material requirements for carbon and low alloy steels for H <sub>2</sub> S containing environments in oil and gas production<br><br>Laboratory Testing of Metals in H <sub>2</sub> S Environments<br><br>Sulfide Stress Cracking Resistant Metallic Material for Oilfield Equipment<br><br>Evaluation of Pipeline and Pressure Vessel Steel for Resistance to Hydrogen-Induced Cracking |
| EFC Publication n° 16 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| NACE TM-01-77         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| NACE MR0175           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| NACE TM0284           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

### Regulations

| Reference      | Title |
|----------------|-------|
| Not applicable |       |

### Codes

| Reference                   | Title                                                                                                                                                                                                                                   |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ANSI B 31.4                 | Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohols<br><br>Gas Transmission and Distribution Piping Systems<br><br>Boiler and Pressure Vessel Code<br><br>Non destructive examination |
| ANSI B 31.8                 |                                                                                                                                                                                                                                         |
| AWS/ASME Section II, Part C |                                                                                                                                                                                                                                         |
| ASME V                      |                                                                                                                                                                                                                                         |

**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 COR 401 | Installation of anodes on submerged pipelines                                                                                    |
| GS EP PLR 211 | Fabrication of seamless pipes for pipelines (mild, intermediate and severe sour service)                                         |
| GS EP PLR 212 | Fabrication of longitudinally submerged arc welded pipes for pipelines (mild, intermediate and severe sour service)              |
| GS EP PLR 231 | Induction bends for pipelines (mild, intermediate and severe sour service)                                                       |
| GS EP PLR 232 | Carbon steel flanges and branch outlet fittings and forged components for pipelines (mild, intermediate and severe sour service) |
| GS EP PLR 233 | Carbon steel tees for pipelines ((mild, intermediate and severe sour service)                                                    |

**3. General****3.1 Definitions**

Definition of terms are those stated in [API Std 1104](#), with additions and modifications given in the following.

|                  |                                                                                                                                                                                                                                                                                                  |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Inspector</b> | Company's authorized representatives or members from Company elected inspection agencies for the time being or from time to time duly appointed in writing by the Company to act as its representative for the purpose of the Contract shall be referred to herein as the "Inspector".           |
| <b>PPS</b>       | This designates the Project Particular Specification as defined in section 1 above.                                                                                                                                                                                                              |
| <b>Site</b>      | This term designates the sites, workshops, worksites, barges, ships or other locations where the prefabrication, welding and installation of the pipeline is performed complete or in part.                                                                                                      |
| <b>Approval</b>  | Authorisation in writing given by Company to Contractor to proceed with the performance of a specific part of the work without releasing in any way Contractor from its obligations and liabilities under the Contract or at law. Approve, Approved and Approval shall be construed accordingly. |



### 3.2 Project Particular Specification (PPS)

The following information shall be provided in the PPS:

1. Clarification on the details of end bevels of free issued products (e.g. when they are different from those stated in General Specifications or related PPS) (refer to section 5).
2. Materials ordered with a simulated PWHT (if any) (refer to section 5).
3. Impact test temperature(s) and impact test absorbed energy requirement for WT above 20 mm (where needed) (refer to § 8.4.2.8).
4. CTOD test temperature (when required) (refer to § 8.4.2.9).
5. The sour service severity and pipeline effluent to clarify the H<sub>2</sub>S test conditions (refer to § 8.4.2.12 and Appendix 10).

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

## 4. Quality Control/Quality Assurance

### 4.1 Quality Control

Responsibility for quality control shall rest with the Contractor aided by such staff as may be required.

Four weeks prior to commencement of any work the Contractor shall prepare and submit a Quality Control Plan which describes the systematic control of the construction, inspection and testing, as dictated by the overall Contract quality programme. The Quality Control Plan shall set forth "witness", "hold", "review" and "monitor" points.

Regarding inspection, the Quality Control Plan shall include:

- A flowchart illustrating each inspection point and its relative location in the procedure cycle, where conformance of characteristics is verified
- The characteristics to be inspected at each inspection point, the procedures and acceptance criteria to be used. The procedures shall be provided to the Company, as requested
- Copies of specific forms used by Contractor to record the results of each inspection.

The Contractor shall maintain quality records as documentary evidence of compliance with quality requirements. Quality records shall be available to the Inspector for analysis and review.

All Contractor inspection systems shall be subject to evaluation and checks by the Inspector to ensure that the system is effectively applied and meets the requirements of this specification.

The Contractor shall employ competent supervisors to ensure that both the standard of workmanship and the quality of materials used comply with the requirements of this specification.

### 4.2 Quality Assurance

The Contractor shall operate a Quality Assurance system in accordance with [ISO TS 29001](#) approved by a Company recognised authority. The Quality assurance Manual shall be submitted prior the start of work.



## 5. Base materials

Pipes and fittings supplied by Company are defined in Company General Specifications listed in section 2 of this specification, and in related PPS.

Unless otherwise stated in the PPS, pipes and fittings supplied by Company will be finished with ends bevelled (refer to line pipe specifications of the order). If the Contractor elects to weld the pipes using a bevel design different from the one supplied, then rebeveling shall be made by Contractor.

When Post Weld Heat Treatment (PWHT) is to be applied to certain weldments, the related welded materials must have been previously tested (e.g. at time of materials order) for tensile and toughness properties after performance of the said PWHT.

## 6. General welding requirements

### 6.1 Standards

Welding requirements shall be in accordance with the requirements of [API Std 1104](#) as modified by the present specification.

The requirements of this specification shall prevail over those of [API Std 1104](#) and where this specification states no overriding requirements, those of [API Std 1104](#) apply in full.

### 6.2 Electrodes, filler wires and fluxes

1. All welding consumables shall conform to [ASME/AWS, Section II, Part C](#) or approved equivalent standard.
2. SAW flux procurement, packing, storage and use shall comply to the requirements of the relevant appendix attached to the present specification.
3. Each heat, lot (or so called batch herein) of consumables shall be subject to inspection and approval by the Inspector. 3.1.b (according to [EN 10204 Std](#)) Mill test certificates from consumables 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 as per "[AWS A5.01-93](#) - § 6.5-Schedule I" as a minimum.

In addition, for SAW flux, testing of granulometry and testing of diffusible hydrogen and/or moisture, shall be required

**Note:** For SAW, re-cycling of flux is not permitted.

4. All welding consumables shall be supplied in sealed, dirt and moisture proof containers. Unopened containers shall be stored in a dry location where a temperature of 20°C and humidity of less than 40% are maintained.

5. The nickel content in consumables shall not exceed 1.0 percent. The use of C-0.5 Mo consumables is not permitted.
6. All welding consumables shall, as a minimum, be stored and handled in accordance with the written Manufacturer's recommendations. Contractor's procedure relative to storing handling, drying, recycling and traceability of consumables shall be approved by the Inspector before commencement of production welding.
7. Each tin or packet of electrodes, or reel of filler wire and bag of flux shall be clearly marked with the respective batch no. In the event of consumables being unmarked or showing signs of deterioration or other damage, they shall be discarded.
8. Each batch of welding consumables shall be subject to welding tests. Test procedure (namely, weld preparation, chemical analysis, mechanical tests, etc.) shall be proposed by Contractor and approved by Inspector.

No retests shall be permitted unless an explanation for the failure is accepted by the Company.

For automatic welding processes, impact tests for each batch of consumables shall be performed under the same conditions and with the same equipment as used for the relevant approved welding procedure.

9. The weld deposits obtained from these consumables. The weld deposits obtained from these consumables shall satisfy the impact toughness, CTOD (when required) and hardness requirements of this specification.

The weld deposits shall have a yield strength which overmatches base material SMYS by at least 80 MPa.

All these properties shall be verified during the welding procedure qualification tests or batch testing.

10. The use of Cellulosic coated electrodes is subject to conditions described in § 6.4.8 and § 6.4.9.

### 6.3 Shielding gas

The requirements of [API 1104](#) shall apply.

### 6.4 Welding process

1. Gas Tungsten Arc Welding (GTAW) and Shielded Metal Arc Welding (SMAW) processes are approved for use.
2. Automatic and semi-automatic welding systems may be offered where the Contractor can give evidence of long and successful practice of the system on similar jobs and requirements, to the satisfaction of Company. Otherwise, the Company will specify special welding and NDT trials, to be completed successfully, before the proposed technique can be approved to proceed for the qualification testing.
3. FCAW process shall be thoroughly controlled at all times by Contractor to avoid any excessive scatters in the mechanical properties (and specially impact properties) of weld deposits. In that view, mechanical test results of qualification test welds shall show sufficient safety margins against requirements of this specification. The Company reserves the right to reject such a process when its reliability is not satisfactory.



4. Only Gas Tungsten Arc Welding process (GTAW) shall be used for pipe diameters less than 2" 3/8 (60 mm).
5. Basic coated low hydrogen electrodes shall be used for all fillet welds.
6. In each case where a semi-automatic and/or automatic welding process or system is approved for use, a manual welding procedure shall be qualified as back up. This requirement may be waived for automatic welding only when Contractor can give evidence of successful past experience and when so specially agreed with Company at the bid stage.
7. Welding processes for anode connecting welds or any other welds to electrically connect attachments (see § 8.6) shall have prior approval of Company.
8. On steel grade X60 and above, cellulosic coated electrodes are not permitted
9. On steel grade up to X56, cellulosic-coated electrodes is allowed provided impact test is not less than -20°C (minus 20°C).
10. Only basic coated low shall be used for welding repairs. The 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). The electrodes shall supply in vacuum packing. Moreover, they shall be guaranteed against moisture absorption for 8 hours after pack opening.
11. Electrical connecting weld shall be qualified as per § 8.6 and connection method shall be as per § 10.20.

## 7. Welding Procedure Specifications (WPS)

### 7.1 General

The WPS for both the main welding procedures and weld repair procedures shall be submitted to Company one month minimum before the start of qualification tests. The WPS shall be accompanied by a summary table showing: process, consumables, direction of welding, type of weld, WPS no., test weld wall thickness and scope of qualification. The welding procedure qualification tests shall not be undertaken until the Inspector has given his approval of the principle on the said WPS.

The WPS shall include, as a minimum, all items listed in clause 5.3.2 or 12.4 (when applicable) of [API 1104](#) and the additional details noted hereafter:

- Manufacturer and trade name of consumables
- Minimum and maximum preheating temperature
- Interpass temperature (minimum and maximum)
- Time lapse between end of root pass and start of hot pass, and end of hot pass and start of 3<sup>rd</sup> pass
- Minimum number of runs before joint is allowed to cool down
- Time at which removal of line-up clamp is allowed
- Nozzle diameter for automatic welding (if applicable)
- Fit-up tolerances and bevel dimensional tolerances
- Oscillation width, dwell and frequency for automatic welding (if applicable)



- Electrode stick-out length (if applicable)
- Scope of qualification in terms of material sourcing, steel grade, O.D. and W.T. groups, CE, Pcm and C%.

All WPS shall conform to **API 1104** together with amendments stated in § 7.2 hereafter and essential variables of § 8.2.

## 7.2 Welding procedure specification information

### 7.2.1 Pipe and fitting materials

Pipe, valves, flanges and fittings from different chemical compositions or grades, or made from material from different sources, or in different supply conditions shall be treated separately and shall require separate procedure qualification. Identical welding procedures qualified on pipes from different sources will also qualify joints between pipes from the two sources and vice-versa provided that both side of HAZ are tested (i.e.: A/A + B/B do qualify A/B or A/B does qualify A/A and B/B).

### 7.2.2 Diameter group - Wall thickness group

Different wall thicknesses and outside diameters shall be qualified separately as shown in § 8.2.

When grouping of wall thicknesses is agreed for qualifications, then the thicker pipe shall be used for the welding tests.

### 7.2.3 Joint configuration

Permanent backing rings or consumables inserts shall not be permitted.

The root gap for fillet welds shall be in between 1.0 to 2.5 mm.

Refer also to § 10.1.e of this specification.

### 7.2.4 Filler metal and number of beads

The number and position of weld beads shall be chosen to give the completed weld a substantially uniform cross-section. No two weld beads shall start at the same point, unless the area is dressed clean and sound before the second bead is started.

Basic coated low hydrogen electrodes with a minimum of two weld passes shall be used for all fillet welds.

For any automatic process, the number of passes shall always be established by a welding test made on each different wall thickness.

Single pass welds or internal root sealing welds shall be minimized (refer to § 13.1 of this specification). This does not apply to an automatic back pass applied internally that is an integral part of the butt weld procedure.

### 7.2.5 Pipe positions/Welding positions

Roll welding and position welding as defined in **API 1104** shall be qualified separately.

For position welding, the following shall apply:

- Horizontal pipes/fittings shall be used to qualify for welds between pipes/fittings within 20° of the horizontal (5G position)



- Vertical pipes/fittings shall be used to qualify for welds between pipes/fittings within 20° of the vertical (2G position)
- Pipes/fittings at 45° to the horizontal shall be used to qualify for welds between pipes/fittings at 20° to 70° to the horizontal (6G position).

2G + 5G qualifies for 6G. However, the 6G position shall not qualify for the 2G and/or 5G position.

### 7.2.6 Direction of welding

For all tie-ins (closing welds), all welds where external line-up clamps are used, and for all repair welds, vertical-up welding shall be used for the root runs. For pipe diameters less than 150 mm and for all welds to valves, flanges or fittings including fillet welds, the complete weld shall be vertical-up.

### 7.2.7 Time lapse between runs

When vertical-down welding is used, the second run (hot pass) shall be deposited immediately after completion of the root run (stringer bead), and the time lapse shall not be greater than that used in the procedure qualification test, with a max. of 15 minutes.

No welds on fittings, tie-ins and repairs shall be allowed to cool below preheat temperature prior to their completion. This requirement also applies to pipe to pipe welds in offshore work. For onshore pipe to pipe welds, a minimum of four runs or one third of weld thickness, whichever is the greater, shall be completed before cooling below preheat temperature provided that this is confirmed by a qualification test. No welds shall be left partially completed overnight.

Reference is made to § 10.12 of this specification.

### 7.2.8 Line-up clamps (refer also to § 10.6)

For pipe to pipe welds on pipes with diameters above 150 mm, an internal line-up clamp shall be used, unless impracticable (e.g. tie-in welds).

### 7.2.9 Preheat/inter-passes temperature (refer also to § 10.3.h/ and § 8.2.15)

A minimum preheat of 100°C (-0/+30°C) shall apply to the welding of fittings, repair welds, tie-ins and fillet welds. The measuring control shall be carried at 50mm distance from bevel ends.

Inter-passes temperature in construction shall not exceed the maximum value achieved in the welding procedure qualification test (WPQ). If the Contractor wishes to exceed 250°C in the qualification test, a similar preheat will be required for the cap in all production welds unless a supplementary procedure test is qualified at a lower inter-passes temperature.

## 8. Welding procedure qualification

### 8.1 General

1. Contractor shall demonstrate by qualification tests that the proposed WPS as well as the equipment he intends to use enable performance of welds and weld repairs meeting the quality and properties required in this specification.



Welding procedure qualifications shall be required for pipe to pipe welds but also for all other welds including fillet welds, fittings to pipes, fittings to fittings (refer to clause 7.2.1 of this specification) and all associated weld repairs (refer to section 14 of this specification).

Welding procedures qualified for previous jobs shall not be accepted.

2. Extreme welding conditions, such as the following ones, which may occur during production welding, shall require qualification tests:
  - 2.a/ For any position/location around the weld, when the heat input variation exceeds +/- 5% in between minimum and maximum, then the minimum and the maximum max heat input shall be individually qualified (refer to § 8.2.11 and 11.3)
  - 2.b/ High-low exceeding 2.0 mm up to 2.5 mm (refer to § 10.2)
  - 2.c/ Interpass temperature beyond 250°C up to 280°C (refer to § 7.2.9 and 10.3)
  - 2.d/ Barge move-up/pipe move-up after root pass (refer to § 10.6 and 10.7).
3. The test welds shall be fully visually inspected and then non-destructively tested according to § 8.4 and 8.5 of this specification prior to conducting the destructive tests. If these inspections indicate the presence of flaws or other defects exceeding the levels permitted in this specification, the reason of this shall be investigated and explained, to the satisfaction of Inspector, before re-welding a test weld to the same (or any other) procedure.
4. All welding procedure qualification tests shall be conducted in the presence of the Inspector.  
The Contractor shall notify the Company of the date and location of the welding procedure qualification tests at least seven (7) working days before the start of the tests.
5. Company shall give final acceptance and approval of all welding processes, systems and procedures.
6. Non-Destructive Testing procedures shall conform to the requirements of section 11 of this specification and, anyway, subject to Company prior approval.
7. The Inspector shall witness all non-destructive examinations and destructive testings and shall review and approve all related results. All mechanical testings shall be carried out by a certified testing facility subject to prior approval of the Company.

## 8.2 Essential variables

The following additional changes in the qualified procedure shall also require re-qualification of the procedure:

1. Any change in Company which performed the qualification test or site where the qualification test weld was produced. Refer also to § 8.3.3 regarding barge welding.
2. Any change in material source, supply condition or manufacturing route of pipe or fitting. A change from seamless to welded pipe and vice-versa. A change between rolled, forged or cast process.
3. Any change in material SMYS groups of **API 1104**, always providing that a higher grade shall qualify for a lower grade, but not vice-versa, in each group.
4. Any increase in Pcm, CE (IIW) or carbon content of more than 0.02% respectively.
5. Any internal high-low exceeding 2.0 mm (refer to § 8.1 and 10.2 of this specification).



6. Any change in impact test requirements (notch location in weld or test temperature). However, for a stated energy absorption requirement at impact test, a lower test temperature qualifies for a higher test temperature.
7. Any change in specified consumable in trade name, classification, source of origin, size or combination. Any change in shielding flux Manufacturer or brand.
8. Any change in pipe diameter from one to another of the following ranges:
  - O.D. < 100 mm
  - $100 \leq \text{O.D.} \leq 325$  mm
  - $325 < \text{O.D.} \leq 610$  mm
  - O.D. > 610 mm
9. Any change in pipe wall thickness beyond  $\pm 20\%$  against that used at qualification test.
10. Any change in pipe position/welding position. Any change from roll to fixed/position welding. Any change in direction of welding.
11. Any change in electrical source of supply, type of current or polarity.
12. Any change in welding heat input outside the one qualified is not permitted (Refer to § 8.1 and 11.3 of this specification).
13. Any change in pass distribution in the weld.
14. Any change of more than  $\pm 25\%$  (rounding to highest integer number is not permitted) in the number of passes obtained at procedure qualification test, for manual and semi-automatic welding.

For automatic welding no change is permitted in the number of passes for a same WT. The number of welding passes may vary in production (-/+ one bead) in accordance with the pipe WT tolerances.
15. Any change in distance between wires or welding bugs if weld temperature does not drop below  $250^{\circ}\text{C}$  before the subsequent pass.
16. Any decrease in preheat from the one recorded during weld procedure qualification (WPQ). The preheat temperature may be increased up to  $30^{\circ}\text{C}$  without re-qualification but any increase of inter-passes over  $250^{\circ}\text{C}$  shall have been previously qualified.
17. Any increase in the time lapse between root and hot pass (second pass).
18. Any removal of line-up clamp or any pipe/barge move-up at an earlier stage. Refer also to § 10.7 of this specification.
19. In the case of plastic strain over 0.5% (i.e.: reeling, etc.), a specific welding procedure qualification program shall be addressed (see Appendix 11).

### 8.3 Welding of test joints

1. The welding equipment shall be the same as or equivalent to that which are intended for use during installation. The test shall be performed on line pipe or other materials, as supplied for the Project, under similar conditions as those expected during installation.



2. Materials to be used in the tests shall be selected with a Carbon Equivalent and Pcm on the upper side of the analysis of the supplied materials and shall be subject to Inspector's prior approval (refer to § 8.2 hereabove).
3. For on-line barge welding (automatic welding), procedure approval test welds shall be made on the pipelay barge. Each pass shall be deposited at the welding station intended to be the normal location for it in production welding.

However, this requirement may be waived and qualification tests may be carried out under simulated site conditions if the same equipment are used and if the specified welding procedure is fully reproduced and representative of site work (removal of line-up clamp, time lapse between passes, pipe movement, etc.) to the satisfaction of Company. This shall be clarified by Contractor and agreed with Company at the bid stage.

Test welds shall be made between full pipe lengths. The use of less than full pipe lengths requires the prior agreement of Company. Anyway, the minimum length of each pipe to be used shall not be less than three (3) metres.

4. For manual or semi-automatic welding tests made on pipe nipples of reduced length (1 metre minimum), a sufficient number of internal strong backs shall be fully fillet welded on pipe to give realistic restraint during welding.
5. Grinding of weld passes between runs shall not be of more extent than that expected on production.
6. When manual welding is to be used, a minimum of one complete test joint is to be made for each Welding Procedure. For semi-automatic or automatic welding equipment, a minimum of three consecutive complete test joints shall to be made.
7. The positions of the longitudinal seams should be chosen to avoid all mechanical test pieces apart from the additional macrosection/hardness test described in § 8.4.2.7 below. The longitudinal seams may be aligned.
8. Fillet test welds shall be carried out as per **API Std 1104** or otherwise agreed with Company.

## 8.4 Testing of welded joints - Butt welds

### 8.4.1 Visual and non-destructive testing

Test welds shall be fully visually inspected, fully radiographed, fully Magnetic Particle Inspected and fully ultrasonically inspected. In any case, NDT technique used during installation and prefabrication (laying, etc.) shall also be applied at this stage.

Test welds shall comply with the acceptance standards stated in section 12 of this specification, except that lacks of penetration at root, lacks of incomplete interpenetration between beads at root area (e.g. between back pass, if any, and root/hot pass) and lacks of root fusion, whatever those defects are surface breaking or not at pipe internal, and surface Copper contamination shall not be accepted at this stage.

Test welds shall satisfactorily pass the above examinations before sampling the mechanical test specimens.



## 8.4.2 Destructive testing

### 8.4.2.1 General

The test welds shall be destructively tested in accordance with [API 1104](#) and amendments stated in the following paragraphs. For semi-automatic and automatic welding (see § 8.3 above), testing shall be made on one test weld only (out of the 3 test welds made).

### 8.4.2.2 Test specimens

The test specimens shall be cut from the joint at the locations shown in Appendix 1 and Appendix 2 of this specification.

Test specimens shall be cut mechanically (sawing, milling). Flame cutting shall only be permitted to facilitate machining, and only if cuts are spaced at least 50 mm from any test specimens.

### 8.4.2.3 Transverse tensile test

Tensile tests transverse to weld are not required for butt welds on pipe less than 4"1/2 (114 mm) in diameter.

Minimum tensile requirements shall be as stated in Company material specifications (see section 3).

### 8.4.2.4 Nick Break test

Nick Break tests are not required.

### 8.4.2.5 Root and face bend test

Root and face bend tests shall be replaced by Side Bend tests for wall thickness greater than 12.7 mm.

### 8.4.2.6 Macrography

The macro-sections shall be ground and polished (diamond paste finished) and etched to show up the Weld Metal and Heat Affected Zones micro-structures.

The macrosection shall be visually examined using a magnification lens of at least X5 to ensure good weld profile and absence of out-of-tolerances imperfections. Acceptance criteria shall be those defined in section 12 of this specification, except that welds shall be free from lacks of penetration and lacks of root fusion at this stage (refer to § 8.4.1 above).

### 8.4.2.7 Hardness test

On the above macrographs, a Vickers hardness survey according to [ASTM E 384](#) (or equivalent Std) shall be made using a 5 kg load as shown in Appendix 3.

One additional macro-section shall be taken where a longitudinal weld intersects the circumferential weld and a hardness survey shall also be carried out at this location.

Another additional hardness test shall be made on the macrosection located at 3 o'clock position for automatic welding processes.