



Welding & NDE of Pipelines (Amend API Standard 1104) Specification

**03.01.10-Welding_&_NDE_of Pipelines_(Amend API Standard 1104)-
Specification**



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Document History

Version No.	Date	Author	Approver	Description of Amendment
1.0	04/03/22	Manas Behera	Mahmood Al Amri	First issue



1.0 Purpose

I. Purpose

The purpose of this document is to define Company specifications and minimum technical requirements and recommendations for fabrication, welding and inspection of new constructed Pipelines designed as per ASME B31.4, B31.8, & B31.12. The purpose of this document is to provide a common welding requirement for all OQ Group of companies' projects.

II. Scope

The scope of this specification is to define additional fabrication, welding, and inspection requirements for pipelines in critical applications as listed below that are having an operational design maximum axial stress $\leq 90\%$ SMYS or installation stress $\leq 100\%$ SMYS:

- All offshore pipelines
- All sour service pipelines
- All pipelines ordered to be resistance to ductile fracture propagations
- All pipelines that will not be falling under non-critical application pipelines as described below.
- Any Pup-piece welding

The onshore non-sour pipelines are categorized as non-critical application if ALL the below stated following conditions are met. Non-critical application pipelines shall be fabricated, welded, and inspected in accordance with minimum stated requirements in API Standard 1104 except for those specifically requested in this specification.

- The design pressure does not exceed 40 barg (580 psig).
- The pipeline has been designed with a design factor of 0.5 or lower.
- The pipeline is designed for the transportation of category A, B or C fluids (i.e. not for D and E fluids). Refer to latest edition of ISO 13623, table-1 for definition of fluid categories.
- The pipeline that is not required to be resistant to ductile fracture propagation and/or the one not subjected to high strains conditions in installation and/or service operation as described in the exclusion section.
- The pipeline has a diameter of DN 250 (NPS 10) or less.
- The minimum pipeline design temperature is 0°C (30°F) or greater
- The pipeline does not form part of a main transportation infrastructure.

Below are excluded from this document.

- Welding of duplex stainless steel pipelines
- Welding of CRA clad pipelines, CRA lined pipelines
- All high strain conditions pipeline i.e., pipelines subject to high strain above normal elastic design limits (more than 0.5%) in installation and/or service OR having an operational maximum axial stress $> 90\%$ SMYS or installation stress $> 100\%$ SMYS. Such pipelines may also be designated for sour service.
- Any excluded scope listed in applicable design code i.e., ASME B31.4, ASME B31.8, and ASME B31.12.
- Manufacture of longitudinally welded pipe/mill products
- Welding on pressurised pipelines (In-service Welding)
- Welding of on-plot pipe work /process piping, pressure vessels, storage tanks
- Structural steelwork

This specification is to be used in conjunction with API Standard 1104, 22nd edition, July 2021. The paragraph numbering corresponds to that used in API Standard 1104 and hence may not be consecutive (Parentheses identify options, substitutions, changes, or additions to API Standard 1104 paragraphs).

For ease of reference, the clause (section or paragraph) numbering of API Standard 1104 has been used throughout "Chapter IV" of this specification.

Such modifications have been denoted using the following nomenclature to indicate the type of change from the API standard:



(Addition)	Additional requirements and/or clarifications have been appended to an existing paragraph.
(Decision)	A decision has been made as required.
(Modification)	Specific revisions have been made to a paragraph.
(New)	A new clause has been added.
(Substitution)	Paragraph replaces corresponding paragraph in its entirety.
(No Modification)	Paragraph or section heading has been referenced herein for clarity.

Clauses (section or paragraphs) in API Standard 1104 not mentioned remain unaltered and in full force.

III. Confidentiality and Distribution

- This document is the property of OQ Group of Companies. Unless otherwise authorized by the Company, the distribution and use of this specification is limited to Company authorities and the Contractors' nominated by the Company. Unauthorized sharing is strictly prohibited and Company shall not bear any responsibility further.
- This document should be part of the ITT/Contract and thus becomes a contract requirement for the Contractor / Vendor to comply with as applicable.
- This document shall be revised only by the document custodian that is OQ Projects, CoE team.

IV. Amendments/Supplements to API Standard 1104, 22nd edition, July 2021

1.0 Scope

1.1 (New) Welding Process Restriction

Roll welding and semi-automatic processes shall not be used.

Oxy-fuel Gas welding, FCAW welding, and flash butt welding processes shall not be used.

Mechanised and automatic welding processes are preferred and should be used whenever possible for pipeline girth welding. Main line welding should be by mechanised or automatic gas metal arc welding (GMAW) which may include single, multi-torch or tandem-arc variants of the process and the use of solid wires. If the use of mechanised or automated GMAW processes is impracticable, alternative processes may be used after obtaining approval from Contractor/Company. In such instances, where approved by Contractor/Company, welding may be performed by conventional pipeline manual welding using shielded metal arc welding (SMAW).

GMAW and GTAW shall be restricted to construction areas protected against wind and draught.

Root and hot pass for all tie-ins/golden weld joints shall be made with GTAW process only.

1.2 (New) Alternative Designs

No modifications to or deviations from this Specification and other relevant Specifications are to be made, unless authorised by the Contractor/Company in writing. Deviation from this Specification shall be clearly documented by Vendor in the tender, otherwise compliance to the requirements herein will be assumed in all respects.

Compliance with this specification shall not relieve the Vendor/Fabricator of its responsibility to supply the fabricated pipeline suited to meet the specified service conditions and applicable regulations.

These requirements apply to all field welding performed by Vendor/Fabricator.



2.0 Normative References

(Addition)

All codes and standards shall be the latest edition current at Purchase requisition issue date including any amendment unless otherwise specified.

2.1 (New) Referenced Project Specifications

All fabricated pipelines and its associated items shall comply as minimum with this specification and below referenced specifications including any additional specifications listed in Enquiry / Purchase requisition as applicable.

03.01.15	Qualification of NDE Procedure Personnel Specification
03.01.22	Project Quality Requirements Specification
03.01.38	Project Non-Conformance Control Procedure
03.01.42	Project Inspection Coordination Procedure
03.01.59	Pipeline Survey Specification
03.01.82	Pipeline Ball Valve Specification
03.01.83	Pipeline Pig Trap Specification
03.01.84	Pipeline Isolation Joint Specification
03.01.158	Metallic Materials Specification
03.01.159	non-Metallic Materials Specification
03.02.10	Quantitative Risk Assessment Corporate Guideline

3.0 Definitions and Abbreviations

3.1 (New) Terms and Definitions

3.1.68 Company:	OQ Group of Companies.
3.1.69 Contractor	is the party who carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Company may undertake all or part of the duties of the Contractor.
3.1.70 Manufacturer/Supplier/Vendor/Fabricator	is the party who performs fabrication or manufacturing or supplying equipment and services to perform the duties specified by the Contractor.
3.1.71 Shall:	The word "shall" indicate a mandatory requirement. Any deviation shall be approved by the Contractor/Company.
3.1.72 Should:	The word "should" indicate a recommendation. A deviation to a recommendation shall be informed and to be accepted by the Contractor/Company.
3.1.73 May:	The word "may" indicates a permission option.
3.1.72 Nominal Thickness (T):	Shall have the following meanings: ○ butt joint; parent metal thickness, which for joints between dissimilar thicknesses is that of the thinner material.



- fillet weld; parent metal thickness, which for joints between dissimilar thicknesses is that of the thicker material.
- Set-on branch connection; thickness of branch pipe at the branch weld toe.
- Set-through branch connection; thickness of main pipe.

3.1.73 Design Code:

The code or standard specified by the Contractor / Company to which the Pipeline or relative pipeline items shall conform.

3.1.74 Verified Copy:

A photocopy of an original document which has been re-endorsed and signed by the organisation producing the photocopy to verify that none of the information has been adulterated.

3.1.75 Main line weld joint

All pipe line weld joints includes tie-ins, pipe to fitting /flange /bends / valve /Isolation Joints designed to pipeline specification.

3.2 (New) Acronyms and Abbreviations

AFC	Approved for Construction
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASNT	American Society for Non-destructive testing
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CE	Carbon Equivalent
GMAW	Gas Metal Arc Welding (MAG - Metal Active Gas)
GTAW	Gas Tungsten Arc Welding (TIG - Tungsten Inert Gas)
HSE	Health, Safety and Environment
HV	Vickers Hardness
IIW	International Institute of Welding
ISO	International Organization for Standardization
J	Joule
MPa	Mega Pascal
MT	Magnetic Particle Testing
NACE	National Association of Corrosion Engineers
NDT (NDE)	Non Destructive Testing (Non Destructive Examination)
NPS	Nominal Pipe Size
PAMS	Portable Arc Monitoring System
PCN	Personnel Certification in NDT
(W)PQR	(Welding) Procedure Qualification Record
(L)PT	(Liquid) Penetrant Testing
QA/QC	Quality Assurance/Quality Control
RT	Radiography Testing
SAW	Sub-merged Arc Welding
SMAW	Shielded Metal Arc Welding (MMA - Manual Metal Arc)
SMYS	Specified Minimum Yield Strength
UT	Ultrasonic Testing



4.0 Specifications

4.1 Equipment

(Addition) Welding power source shall be equipped with display units of ammeter and voltmeter. GTAW machines shall be equipped with High frequency unit. All equipment shall be calibrated.

4.2 Materials

4.2.1 Pipe and Pipe Components

(Addition) F) Material in accordance with ISO specifications.

All materials used in fabrication shall have an inspection certificate level as indicated in the material requisitions and/or datasheets.

The Contractor/Fabricator shall obtain verified copies of the materials certificates for all free-issue items to be welded. Manufacturer/Vendor-supplied items shall have original or verified copies of materials certification. Items without materials certificates shall not be used unless they are re-certified by testing.

4.2.2 Filler Metal and Fluxes

(New) Type and Sizes

The yield strength of the filler metal shall be selected to ensure that the yield strength of the deposited pipeline girth welds overmatches the actual yield strength of the parent pipe material.

All welding consumables & fluxes used in fabrication shall have an inspection certificate in accordance with ISO 10474 type 3.1 or EN 10204 Type 3.1. Full 3.1 certification (both chemical and mechanical properties through batch testing) shall be needed. For automated GMAW, each batch of welding consumables tested in accordance with applicable consumable classification specification, shall be offered for Contractor/Company witness.

All consumables shall be identified on the WPS by their AWS classification along with their manufacturer brand/trade name.

4.2.2.1 Types

(Addition)

Company-approved Manufacturers shall be used.

For sour service, the deposited nickel (Nickel) content in the weld metal does not exceed 1.0%. Any other requirements stated in NACE MR0175/ISO 15156 shall be complied for sour service applications.

4.2.2.2 Storage and Handling

(Addition)

All consumables shall be stored, handled and used in accordance with the Manufacturer's instructions. The preference shall be for consumables such as low-hydrogen coated electrodes to be supplied dry in hermetically sealed vacuum-packed metal containers.

Consumables can be supplied in individual small vacuum packs sufficient for one welder to use in one shift. Vacuum packed consumables preclude the need for electrode quivers and reduce consumable control difficulties. In the event that conventional (non vacuum packed) consumables are used, then these shall be baked prior to use and stored in dry warm low humidity conditions and issued directly to the welders personal heated quiver for use. All unused electrodes shall be returned to store at the end of the shift for re treatment and possibly re drying if required. Re baking of electrodes shall be only as recommended by the consumable manufacturer. Hydrogen controlled SMAW electrodes shall not be re-dried unless a specific re-drying cycle has been agreed by COMPANY. Color coding shall be used to identify re-baked electrodes. Only one re-baking is allowed.

Following receipt and inspection the consumables should be promptly transferred to the storage area. All welding consumables including submerged arc flux shall be kept and stored in low humidity (50% maximum relative humidity) & warm (minimum 50°C) controlled storage area. Humidity and temperature shall be continuously recorded. Flux can be recovered and recycled twice only before it is discarded.



Drying and elevated temperature storage (holding) shall be performed in purpose-built, thermostatically controlled ovens. These ovens shall be fitted with a temperature indicator and should also be equipped with a temperature recorder. Ovens shall not be overloaded, and individual shelves shall contain no more than four layers of electrodes. Each type and size of consumable shall be clearly marked and segregated within the drying and storage (holding) ovens.

Detailed consumable control procedures shall be required for Contractor/Company review and acceptance prior to the start of site welding activity.

Any consumables that cannot be positively identified or that show signs of deterioration shall not be used.

4.2.3 Shielding Gases

4.2.3.1 Types

(Addition) Shielding and purge gases shall be certified as complying with ISO 14175/AWS A5.32. Premixed gas cylinder shall be used in case of mixed gas applications. The purity or component concentrations of the gas shall be as specified on the WPS and shall be the same for procedure qualification and production welding.

5.0 Qualification of Welding Procedures with Filler Metal Additions

5.1 Procedure Qualification

(Addition)

The PQR and WPS shall be approved by the Contractor/Company. No production welding shall commence until the welding procedures and PQRs and qualified welders are approved by the Contractor/Company. Welder performance qualification testing shall be carried out in accordance with API Standard 1104. Welder qualification test shall be witnessed by the Contractor/Company or its representative. Procedure qualification shall be witnessed by Contractor Welding Engineer and Company representative.

Approval of Preliminary Welding Procedure Specifications (pWPSs) subjected to company agreement on case by case basis.

The same brand name and manufacturer consumables used for procedure qualification shall be used for production welding.

5.2 Record

(Addition)

The PQR shall include the following Documents, as minimum:

- The actual welding details and other details specified in Section 5.3 of this specification
- Material certificates for the base materials as stated in the material requisitions and/or datasheet plus full 3.1 certificates for the consumables/fluxes (refer to clause 4.2.1 & 4.2.2) including consumables brand name, manufacturer, and heat-lot/batch, as applicable.
- Batch test certificate of Welding consumables/fluxes.
- Nozzle diameter for automatic welding (if applicable)
- Oscillation width and frequency for automatic welding (if applicable)
- Portable Arc Monitoring System (PAMS) printout of the welding parameters
- Summary of recorded welding parameters including heat input calculation
- PWHT records (as applicable)
- Visual inspection and NDT reports (both surface crack detection and volumetric inspection records)
- Macrographs
- All mechanical/chemical test results, as required by the applicable design code, this specification, and any other applicable project specification.

5.3 Welding Procedure Specification

The below stated requirements shall also be applicable to pWPSs.

5.3.1 General



(Addition)

Welding procedure specifications (WPS) shall provide for each type of joint and nominal size to be joined. These shall clearly identify all of the code essential variables (and supplementary essentials, where necessary), materials and specifications, consumables by manufacturer/trade and brand name including SFA and AWS classification and all other standard/Code requirements.

The WPS shall indicate the expected number of passes (beads) for particular joint thicknesses and the welding conditions to be used for each joint. Refer Section 5.3.2.4 of this specification for more details.

The root pass of butt and branch joints shall be such as to ensure full and regular penetration, without excess internal reinforcement.

The WPS shall show the following information in addition to those requirements stated in API Standard 1104.

- Date & Revision Number
- Project Identifications (i.e., Contract number, Project title, and Client name)
- Contractor/Fabricator's Logo, signature, and endorsement
- Qualified PQR(S) number(s)
- Consumables brand name, manufacturer, and heat-lot/batch, as applicable
- Nozzle diameter for automatic welding (if applicable)
- Fit up tolerance
- Oscillation width and frequency for automatic welding (where applicable).
- Electrode stick-out length (where applicable).
- Applicability to welded or seamless pipe
- MDMT
- Internal/external coating, as applicable
- Service requirements (such as Sour or Non-Sour service or else, as applicable)

5.3.2 Specific Information

5.3.2.2 Materials

(Addition)

The maximum carbon equivalent (CE) of production materials shall be restricted to the requirements stated in applicable material specification/standard as well as the material requisition.

When two materials with different CE are used, the range qualified shall be $+0.03\%$ of CE_{iiw} of respective material, provided impact testing is carried out at the FL and FL+ 2mm positions on both sides of the of the test weld (where weld configuration/thickness permits)

5.3.2.3 Diameters and Wall Thicknesses

(Addition)

The diameter range shall be as shown in the following table:

Test Weld Outside Diameter, D	Qualified Diameter Range
≤ 60.3 mm	Same Diameter Qualified
≥ 88.9 to ≤ 323.9 mm	0.5D to 2D but not more than 323.9 mm
> 323.9 mm	0.5D to 1.5D

For branches (including weld-o-lets) D means outside diameter of the branch/weld-o-let at the weld toe.

Qualified thickness range shall be as per Table-1 of API Standard 1104.

5.3.2.4 Joint Design

(Addition)

The WPS shall include allowable tolerances of the bevel angle, root gap and root face.

Permanent backing bars shall not be used.

Joint design as shown in applicable design code (i.e. ASME B31.8 or ASME B31.4 or ASME B31.12) shall be used. Usage of other joint design shall be subjected to Contractor/Company approval.



5.3.2.5 Filler Metal, Flux and Number of Beads

(Addition)

For SMAW process, if permitted and utilized, it is expected that cellulose coated electrodes to be used for the root and hot passes and fill out with either cellulose or basic coated low hydrogen electrodes qualified and approved in a suitably qualification procedure. Alternatively, for root and hot pass welding, manual or automated gas tungsten arc welding (GTAW) is also permitted following Contractor/Company acceptance of a suitably qualified procedure.

For SMAW, maximum bead width should be restricted to 2.5 times the electrode diameter.

Three or more weld passes shall be deposited for pipe wall thickness greater than or equal to 4.8 mm.

For fillet welds used for attachment of supports etc. the number and pass sequence shall be detailed as applicable for particular fillet weld throat sizes. Single pass fillet welds shall not be permitted.

5.3.2.6 Electrical Characteristics

The allowable range of heat input rates to be applied by each welding process for each pass shall be specified.

5.3.2.7 Flame Characteristics

(Substitution) Replace existing section as follows:

Oxy-fuel gas welding shall not be used.

5.3.2.8 Positions

(Addition)

WPSs for manually welded line pipe butt joints shall be qualified in the 5G position to cover production welding 5G positions. Automatic welds shall be qualified for each position to be used in production.

Branches, flanges attachment welds and connected ancillary piping may be qualified in the production welding position or, to cover all positions, in the 6G position, at the option of the Fabricator.

(Addition)

Permitted tolerance for terrain inclination for Pipeline Welding to be as per below:

For automatic welding maximum 5 degrees tolerance and for manual welding maximum 15 degrees can be permitted, provided the procedure qualification carried out in simulated conditions.

Unless welding procedure and welders are qualified in 6G, any change outside above tolerance shall be called for re-qualification.

5.3.2.9 Direction of Welding

(Addition)

For the following, the root bead shall be deposited with a vertical-up progression:

- Tie-in welds
- Welds where an external line-up clamp is used
- Welds to fittings/flanges and branches
- Full penetration repairs
- Welds where temporary tack welds have been employed for alignment

For the following, the complete weld shall be made with a vertical-up progression:

- Weld to valve/Pup Piece
- Branch and Fillet welds
- Golden weld joints

5.3.2.10 Time between Passes

(Addition)

The hot (second) pass shall be deposited immediately after completion of the root run and the time lapse shall not be greater than that used in procedure qualification, and shall not be greater than 10 minutes. The maximum time for other passes shall not be greater than that used in qualified procedure.

5.3.2.11 Type and Removal of Line-up Clamp



(Addition)

Replace last sentence as follows:

An internal or external line-up clamp shall be used for all girth welds except where it is demonstrated that to do so would be impractical. An internal line-up clamp shall be used for butt welds in pipe above 323.9 mm (12") OD. Where no line-up clamp is feasible, tack welding may be permitted subject to Company approval.

An internal line-up clamp shall not be removed until deposition is completed of the first two passes. An external line-up clamp shall not be removed until the root bead is at least 50% complete, equally distributed around the joint.

When automatic GMAW process is used, internal line-up clamp may be removed after completion of one complete root pass provided internal clamp is removed after lowering the pipe on to the skid.

Based on the qualification, the minimum number of passes to be deposited before the pipe is lowered off shall be stated in WPS.

See also Section 7.3 of this specification.

5.3.2.13 Preheat and Interpass Temperature

(Addition)

The maximum inter-pass temperatures and temperature control methods shall be specified.

The preheat temperature shall not be lower than that recorded during Welding Procedure Qualification testing (WPQT).

The inter-pass temperature shall not be less than the preheat temperature and shall not exceed the highest value recorded during WPQT.

See also Section 7.10 of this specification.

5.3.2.15 Shielding Flux

(Addition)

The AWS classification for the flux, and the manufacturer/trade and brand name shall be specified and shall be similar to the one used in the qualified PQR.

5.3.2.20 (New) Bead Map

(New)

A sketch of the weld cross-section showing the bead sequence shall be made for each WPS.

5.3.2.21 (New) Number of Welder

(New)

The WPS shall designate the number of welders for root pass and hot pass (second pass).

For pipe larger than NPS 12", a minimum of two welders shall be employed for all passes.

5.3.2.22 (New) Partially Completed Joint

(New)

The minimum number of passes before the joint is allowed to cool to ambient temperature shall be specified.

The minimum shall be three passes or one third of the joint whichever is greater.

See also Section 7.12 of this specification.

5.3.2.23 (New) Tungsten Electrode for GTAW

(New)

The AWS class for tungsten electrode shall be specified in the WPS.



5.4 Essential Variables

5.4.1 General

(Addition)

Welding procedures shall not be transferred from one contractor or sub-contractor to another without requalification.

5.4.2 Essential Variables Categories

(Addition)

With reference to the welding variables sub-sections column in Table-1 of API Standard 1104, the changes requiring requalification shall also be as per the below in addition to those highlighted in Table-1 of API Standard 1104. This is applicable to both Category I (standard WPS) and Category II (WPS with hardness and/or toughness).

5.4.2.2 Base Material

(Addition)

- Unless otherwise agreed with Contractor/Company, the welding procedure shall be qualified on project material.
- Where SMYS of material specified as $\geq$ ISO 3183 L415 (API 5L X60), then each combination requires qualification.
- For sour service, any change in material grades with SMYS $\geq$ 415Mpa.
- A change in pipe manufacturing process and/or heat treatment condition
- Any change in pipe diameter outside the limits given in Section 5.3.2.3 of this specification shall be considered as an essential variable hence the need for re-qualifications.
- Any change in carbon equivalent value outside the limits given in section 5.3.2.2 of this specification.

5.4.2.5 Position

(Addition)

Any change in position outside the limits given in Section 5.3.2.8 of this specification shall be considered as essential variable.

5.4.2.6 Filler Metal

(Addition)

The following shall be considered as essential variables in addition to those stated in API Standard 1104 table.

- Any change in wire/filler metal AWS classification, manufacturer/trade, and brand name
- Any change in wire/flux AWS classification, manufacturer/trade, and brand name
- A change in the diameter of electrode or filler wire
- Any relaxation in drying or other pre-treatment procedure
- Filler metal shall have matching strength, impact properties as that of base metal, except for root pass

5.4.2.11 Pass sequence

(Substitution)

Any change in the sequence of deposition, e.g. a change from temper bead deposition pattern, shall be considered an essential variable.

(New)

5.4.2.15 **(New)** Interpass Cleaning

The method of interpass cleaning shall be considered an essential variable.

5.4.2.16 **(New)** Number of Welders



A change in the root pass and hot (second) pass number of welders shall be considered an essential variable.

5.4.2.17 **(New)** Type and Removal of Line-up Clamp

Removal of the line-up clamp at a stage earlier than qualified shall be considered an essential variable. Also, any change in type of line-up clamp shall be considered an essential variable.

5.4.2.18 **(New)** Partially Completed joint

Any change in the minimum number of runs before the joint is allowed to cool shall be considered an essential variable. The welding of tie-in joints, weld repair, fittings and flanges shall be completed without any interruption i.e., shall not be allowed to cool down before completion.

5.4.2.19 **(New)** Tungsten Electrode Classification

Where the GTAW process is used, any change in the tungsten electrode AWS class and size shall be considered an essential variable.

5.5 Welding of Test Joints—Butt Welds

(Addition)

The test weld shall be made under conditions which simulate production welding to a degree satisfactory to the Contractor/Company. Each test weld shall be made using actual project pipe materials.

For pipeline automatic welding and manual welding with internal clamp procedure qualification, two full length pipes shall be welded together using production welding line up clamping equipment.

For pipeline manual welding procedure qualification, two pipe in adequate lengths shall be welded together using production welding line up clamping equipment. The minimum length of pipe for weld tests shall be one diameter or 0.5 metre whichever is greater, so that completed test weld length is 1.0 metre minimum. Where necessary, a further two pipe in adequate lengths as described shall be welded to obtain the required number of specimens for testing. Welds shall be made at the construction site using site equipment and welders that will be used on the pipeline construction.

All qualification welding shall be witnessed by the Contractor/Company's Welding Engineer / Inspector.

The Fabricator shall give the Contractor/Company a minimum of 72 hours' notice of the intention to proceed with testing of the welded joint.

Immediately prior to test welding, the Fabricator shall make available the following documents at the test site for Contractor/Company's inspection:

- pWPS endorsed "Approved for Qualification"
- Materials certificates, or verified copies, traceable to the items to be welded
- Welding consumable batch certificates, or verified copies, traceable to the welding consumables
- Approved consumable handling procedure
- Calibration certificates of equipment.

The Contractor shall use calibrated Portable Arc Monitoring System (PAMS) with hard copy facility. Alternatively, electrode run-out method may be used for SMAW.

5.6 Testing of Welded Joints—Butt Welds

(New)

Test welds for all welding procedure qualifications shall be subjected to NDT as detailed below before sectioning for destructive testing in accordance with Section 5.6 of API Standard 1104 as well as this specification.

The test weld shall not be subjected to PWHT or NDT until a minimum of 24 hours has elapsed after the completion of welding. Where post-weld heat treatment is necessary, this shall be performed prior to NDT.

The NDT shall consist of all the following:

- Visual examination
- Magnetic particle testing / Liquid Penetrant Test
- Radiographic testing or AUT (Automatic UT). Where any bead has been deposited by GMAW process, automatic UT on test welds shall be mandatory in addition to RT.



NDT on all test welds shall be performed with the weld at ambient temperature using the equipment and approved procedures that will be employed for production. NDT of a test weld may serve as a qualification test for the NDT procedures and shall be witnessed by the Contractor/Company's Inspector. Ultrasonic testing procedure qualification shall be offered for Contractor/Company witness.

The acceptance criteria for various NDT shall be as stated in Section 9 of API Standard 1104 and this specification. Any weld that fails to meet the acceptance criteria shall not be offered for destructive testing.

Following Contractor/Company approval of the NDT, all test welds shall be sectioned at the locations shown in Figure-3 of API Standard 1104 and Figures-1 & 2 of ISO 13847 (latest edition), as necessary. Sectioning and testing shall be performed at certified testing laboratories approved by Contractor/Company.

Destructive testing for all welding procedure qualifications shall be performed in accordance with API Standard 1104 and any additional requirements stated in this specification (Section 5.6.6 to 5.6.11).

The type and number of test specimens stated in Table-3 of API Standard 1104 for sizes 4inches and below shall be replaced with those stated for sizes exceeding 4inches up to 12inches. Also, as necessary, the additional testing requirements stated in this specification (Section 5.6.6 to 5.6.11) shall amend the type and number of test specimens stated in Table-3 of API Standard 1104.

All testing shall be witnessed by a Contractor/Company's Representative. All test reports shall be endorsed and signed by the approved testing organisation, the Fabricator, and the Contractor/Company's Representative, who witnessed the testing.

Testing Organization shall be accredited as per international standards and code requirements or equivalent. All test reports and the certificate of conformance shall be included in the PQR.

(New)

5.6.6 (New) Hardness Testing and Macroscopic Examination

Hardness testing and Macroscopic examination testing shall be performed for both critical and non-critical application pipelines as described in the scope of this specification.

5.6.6.1 Preparation

Specimens shall be prepared for macroscopic examination by grinding to a minimum finish of 600 grit. The prepared surfaces shall be ground, polished and etched using a suitable etchant to clearly reveal the weld and HAZ microstructure and the presence of macro defects.

Macro exam and hardness testing sections shall be taken from each weld from the position shown in Figures-1 & 2 of ISO 13847 (latest edition).

5.6.6.2 Method

The macro-sections shall be examined at a minimum magnification of x5.

The sections of the weld taken for macroscopic examination shall be used for hardness testing. Macro-photographs showing the hardness indentations shall be included in the PQR.

For pipe butt welds, the hardness indentations locations shall be as minimum in accordance with NACE MR0175/ISO 15156. The hardness shall be measured in accordance with ASTM E92, using HV10.

5.6.6.3 Requirements

The macro-sections shall not show defects exceeding the acceptance standards given in Section 9 of API Standard 1104 and this specification.

For sour service, maximum hardness limitation at each measuring location for weld metal and HAZ shall be in accordance with NACE MR0175/ISO15156 requirements.

For non-sour service applications, the maximum hardness restriction at each measuring location shall be limited to Table-12 of API Standard 1104.

(New)

5.6.7 (New) Charpy V-Notch Impact Testing

For both critical and non-critical application pipelines as described in the scope of this specification, Impact testing shall be done in accordance with ASTM A370 or ISO 148 and this specification.

Each procedure qualification shall include impact testing when the nominal pipe wall thickness exceeds 6mm.



5.6.7.1 Preparation

All Charpy tests shall be 2mm transverse Charpy “V” notch. Transverse Charpy Impact test sets in accordance with ASTM A370 or ISO 148 shall be taken as follows from the positions shown in Figures-1 & 2 of ISO 13847 (latest edition):

- Centre of Weld
- Fusion Line (FL) – (Not mandatory for non-critical application pipelines)
- FL + 2 mm (HAZ)
- FL and FL+2 charpy to be conducted on both sides in case of pipe to fitting /flange weld
- FL + 5mm - (Only for welds made with the SAW process permitted by the Contractor/Company).
- Each test set shall consist of 3 specimens and both single and average energy values shall be reported.

For single sided groove design, and where the welded thickness is less than or equal to 20mm (i.e., $\leq 20\text{mm}$), Charpy Impact specimen locations shall be taken at the weld root from 1 mm to 2 mm above the inner surface of the pipe; Where the welded thickness is above 20mm, another set of specimens shall be taken at the weld cap from 1mm to 2mm below the outer surface in addition to the root specimens.

For the weld metal thickness more than 6mm, When combination of welding processes or welding consumables are used, specimens representing each process and consumables shall be tested for Weld, FL, and FL+2 mm. Mode of metal transfer also constitute to as a change in process.

If double sided groove joints are used, location of test sample shall be from root (inner side), cap (outer side) and mid weld section.

Impact test specimens shall be full size 10 x 10mm wherever possible. Where the dimensions do not permit the preparation and testing of full size CVN test pieces, Sub size specimens are permitted but the minimum energy required shall be proportional to cross sectional area beneath the notch. Reduced size (sub-size) Charpy impact test specimens shall only be permitted for materials/weld below 12mm but exceeding 6mm thickness. The thickness of subsized specimens should have at least 80% of the wall thickness of the test coupon otherwise testing at lower temperature than the test temperature stated must be conducted. Lowering the test temperature in such circumstances shall be agreed with Contractor/Company.

5.6.7.2 Test Temperatures and Acceptance Criteria

The impact test temperature for welds not subject to PWHT shall be as shown in Table-A below but shall in no case be higher than 0°C. For welds subject to PWHT the test temperature shall be equal to the minimum design temperature (T°C).

Table A: Impact test temperature (for welds not subject to PWHT)	
Nominal wall thickness (t), (mm)	Test temperature, (°C)
$t \leq 20$	T
$20 < t \leq 30$	T-10
$30 < t \leq 40$	T-20
$t > 40$	T-30
T = minimum design temperature	

The required impact energy for full sized specimens shall be as follows:

- Minimum average energy (of set of three specimens) shall typically be equal or more than material's SMYS/10, but shall in no case be lesser than 27J.
- Minimum individual energy (of set of three specimens) shall not be less than 70% of the minimum average energy value.

Where material's SMYS is given in MPa and impact energy values are in Joules. For each set of three specimens, only one of the individual values may be below the minimum average energy requirement with an absolute minimum as defined by the minimum individual acceptance criterion.

(New)

5.6.8 (New) All Weld Metal Testing

This test is only required for critical application pipelines as described in the scope of this specification.



All weld metal test specimens shall be prepared and tested in accordance with ISO 5178.

If the design temperature of the pipeline exceeds 75°C, testing shall be carried out at the upper design temperature.

Testing shall be in accordance with ISO 6892-1 (i.e., tensile testing at ambient temperature) or ISO 6892-2 (i.e., tensile testing at elevated temperature), as appropriate.

Full stress strain curves shall be provided.

The measured yield strength shall be greater than or equal to the SMYS of the parent pipe metal, or any other value established by agreement with Contractor/Company.

All weld metal testing sections shall be taken from each weld from the position shown in Figures-1 & 2 of ISO 13847 (latest edition).

(New)

5.6.9 (New) Corrosion Testing for Resistance to Sulphide Stress Cracking in Sour Service Pipelines

Unless otherwise specified by the Contractor/Company, corrosion testing for resistance to sulphide stress cracking (SSC) is not required for pipelines in sour service, provided the SMYS of the pipeline material $\leq 450\text{MPa}$ (i.e. grade X65 and lower grades) and the maximum axial stress during operation will not exceed 90% of SMYS.

However, in sour service, and for material grades with SMYS exceeding 450Mpa (i.e. grade X70 and above), 4-point bend testing shall be carried out in accordance with, EFC 16 Appendix 2, or ISO 7539-2, or NACE TM 0316. The tests shall be performed with the internal surface in tension and in the as-welded condition at a strain equivalent to 90% of Actual Yield Strength (AYS). For pipelines where the installation stress exceeds 100% SMYS and is exposed to sour conditions in operation, but where the operational axial stress is $\leq 90\%$ SMYS, 4-point bend SSC testing shall be carried out on weld samples that have been subjected to strain cycles equivalent to the maximum anticipated in installation. Similarly, the testing shall be in accordance with EFC 16, Appendix 2, or ISO 7539-2, or NACE TM 0316.

The strain shall be measured by strain gauges attached directly to the specimen, adjacent to the weld root fusion line.

(New)

5.6.10 (New) Retests

5.6.10.1 General

If the results of destructive testing are unsatisfactory owing to defective specimen preparation or a localised weld defect, obtaining approval from Contractor/Company to proceed with retests as detailed below shall be needed.

5.6.10.2 Tensile Tests and Bend Tests

If one tensile or bend specimen does not meet the acceptance criteria stated in API standard 1104, two additional specimens shall be tested. Both of the additional specimens shall meet the acceptance criteria.

5.6.10.3 Hardness Tests

If one hardness result exceeds the specified maximum, then three further impressions shall be made in close proximity to the one failed such that they do not mutually interfere. If all of the further tests are below the specified maximum, then the test shall be accepted.

5.6.10.4 Charpy V-Notch Impact Tests

If the specified minimum average value has been achieved and more than one specimen is below the specified minimum average value but not below minimum absolute energy value for single test specimen, a retest of three further specimens shall be permitted. The location of the retest specimens shall be from the same area as close as possible to the location of the original specimens. All three individual retest values shall equal or exceed the specified minimum average value.

5.6.10.5 New Procedure Requirement

If the test joint fails to meet the minimum requirements, a new pWPS proposal shall be established and qualification welding and testing shall all be repeated.



5.7 Welding of Test Joints - Branch and Fillet Welds

(Addition)

Low-hydrogen electrodes shall be used for all fillet welds and branches, wherever SMAW is used.

Test welding shall be witnessed by the Contractor Welding Engineer/Company Welding Inspector. Branch weld test joints shall be welded using qualified butt weld procedure. A test fillet weld using a minimum of two weld passes shall be made. Branch and fillet welds can be qualified on butt weld joints as well in accordance with the requirements stated in Section 5.5 & 5.6 of this specification.

5.8 Testing of Welded Joints - Branch and Fillet Welds

(Addition)

Fillet test welds shall be visually inspected and magnetic particle tested after a minimum of 24 hours has elapsed from completion of welding. If the weld is deemed acceptable in accordance with the appropriate acceptance criteria detailed in Section 9 of API Standard 1104 and this specification, it may be offered for destructive testing.

Fracture tests shall be performed by breaking specimens with the root of the weld in tension, using either the method stated in API Standard 1104 or one of the following methods:

- supporting both ends and striking the centre of the specimen; or,
- gripping one end and striking the other

The exposed surface of each broken specimen shall be free from cracks, lack of fusion and lack of penetration. The acceptance criteria for other imperfections in the weld metal shall be as per API Standard 1104.

(New)

5.8.4 (New) Macroscopic Examination and Hardness Testing

Branch and fillet welds shall be qualified by macro and hardness survey at the same sections and numbers shown in Figure-10 of API standard 1104 for fracture testing. Each section shall be prepared, and macro examined for weld shape penetration, fusion and quality all shall be acceptable. The macro-sections shall be examined at a minimum magnification of x5.

The sections of the weld taken for macroscopic examination shall be used for hardness testing. Macro-photographs showing the hardness indentations shall be included in the PQR. Hardness testing measuring locations shall be done as minimum as per NACE MR0175/ISO 15156. The hardness shall be measured in accordance with ASTM E92, using HV10.

For sour service, maximum hardness limitation at each measuring location for weld metal and HAZ shall be in accordance with NACE MR0175/ISO15156 requirements.

For non-sour service applications, the maximum hardness restriction at each measuring location shall be limited to 325 HV10 for both weld metal and HAZ.

(New)

5.8.5 (New) Retests

In case of failure to meet the requirements for destructive testing in 5.8 resulting from the presence of weld imperfections, two further test specimens shall be obtained for each test specimen that failed. If either of these additional specimens does not comply with the requirements, the preliminary WPS shall be regarded as not complying with API Standard 1104, and shall be modified before continuing with test welding.

In case of failure to meet the requirements for destructive testing in 5.8 for other reasons, one additional test piece may be welded and subjected to the same inspection and testing.

6.0 Qualification of Welders

6.1 General

(Addition)

Welders employed on pipeline welding shall have demonstrated experience in pipeline welding.



Welders shall be qualified for each welding process that they will use in production.

Welders shall have a valid qualification within the validity defined in this specification or they shall be qualified using the Approved for Construction WPS. Qualification shall be valid for a period of six months. This period may be extended every six months when it can be shown by NDT from production welding and demonstrated statistical repair rate of less than 2%.

6.2 Single Qualification

6.2.2 Scope

(Addition)

Add sub-section "L" as below:

L) The below additional essential variables shall also be met:

1. For SMYS $\geq$ 415 MPa, a welder qualification using material of a given SMYS qualifies the welder for materials of equal or lower SMYS.
2. For mechanized welding, each operator shall be qualified for a particular part or parts of the operation of making a weld joint. Under no circumstances shall an operator be employed on operations other than those for which they have been tested, qualified and approved.

6.5 Destructive Testing

6.5.1 Sampling of Test Butt Welds

(Addition) Tensile test to be carried out for materials with SMYS 415 Mpa and above.

6.6 Nondestructive Testing (NDT)—Butt Welds Only

6.6.1 General

(Addition) All welders shall be qualified by NDT applicable for production welding prior to mechanical testing.

7.0 Design and Preparation of a Joint for Production Welding

7.1 General

(Addition)

- No production welding shall be carried out before the WPSs is 'Approved for Construction' by the Contractor/Company and the welders qualified to weld using the approved WPSs.
- The approved WPSs shall be available at the location of welding.
- Fusion faces and the surrounding surfaces within a minimum of 25mm of the joint shall be free from heavy scale, moisture, oil, paint, or any other substance which may have a deleterious effect on the weld quality or progress.
- Arcs shall be struck only on fusion faces. Stray arc strikes shall be removed by grinding. The ground area shall be magnetic particle tested and thickness checked. Where the thickness is below the specified minimum, the section of pipe shall be removed. The Fabricator shall ensure a good earth connection and periodically examine the condition of the earth cables and attachments. Any arcing from a poor connection shall be treated as an arc strike. Connections shall be made to the work by copper or brass clamps. Earth cables shall not be welded to pipeline components.
- A Contractor/Company's approved circular cap to prevent entry of foreign material shall be used to cover open ends of the pipe when interruptions to work expected. Claw type plugs or any type liable to damage the pipe shall not be used. All open ends of pipe strings shall be capped off and sealed when welding is completed.
- If AUT is to be used, a reference line at a specified distance from the root face shall be scribed onto the pipe surface to allow the AUT equipment to identify the exact location of the root bead.
- Repair of the pipe body by welding shall not be permitted.
- Welding operations shall not be performed when the Welding inspector is not present at the location of welding.



7.2 Alignment

(Addition)

Hammering, (apart from minor cold dressing using a bronze-headed hammer), welding of temporary attachments or any other heating of the pipe shall not be permitted.

The maximum permitted offset at any one point shall be 2.0mm for pipe up to and including 12 inch NPS and 3.0mm for larger diameters. Misalignment in excess of these limits resulting only from dimensional variations within the specified tolerances, or from abutment of two pipeline components of different nominal thickness and the same outside diameter, may be rectified by tapering the bore of the thicker component at an angle no steeper than 1:4.

When a pipe with one longitudinal seam is used, this seam shall be within the top 120° of the circumference. The longitudinal seams of consecutive pipes shall be offset by at least 45° or 100mm whichever is higher. Longitudinal welds in fittings are exempted. The longitudinal weld of the cold bend shall be located approximately within 10° from the pipe's neutral axis.

Tack welds shall be avoided wherever possible. Where demonstrated to be unavoidable and approved by the Contractor/Company, temporary bar tacks shall be employed using suitable carbon steel material. Preheat shall be employed if required by the WPS and welding parameters shall be in accordance with the appropriate fill pass.

Tack welders shall be qualified to weld with the WPS.

7.3 Use of Line-Up Clamp for Butt Welds

(Addition)

Internal line-up clamps shall be used for butt welds in pipe 400 mm OD and larger. External line-up clamps may be used for butt welding smaller pipe sizes and for tie-in welds in any size of pipe, or for special welds, such as connections to valves, flanges and fittings.

Pipe shall not be moved or lowered off until the second pass has been completed except as permitted in Section 5.3.2.11 of this specification for the automatic GMAW process.

When tacking required, the preferred method is bullet tacking. The bullet shall be made from compatible line pipe material and shall be removed as the welding progresses.

7.4 Bevel

(Addition)

For Field Bevelling, after grinding, the bevelled edges shall be visually and MT examined. Any bevelled edge that has been damaged shall be restored. Restoration involving welding is not permitted. Should any defect found, the pipe shall be investigated and examined and shall meet original pipe requirements.

Weld bevels shall be prepared by machining with a floating head cutter. The bevelling machine shall follow the ID surface contour in order to ensure a consistent root face dimension. Mechanised thermal cutting may be accepted for tie-in welds. The cut surface shall be ground back nominally 2mm (1/16 in). Manual cutting of field bevels are not permitted.

In case of automatic GMAW, if original bevel is modified to meet WPS requirement and original bevel not removed by more than 10mm from end of the pipe, no MT is required.

Where pipes are cut, pipe markings shall be transferred to the off-cut in order to maintain identification.

7.7 Cleaning Between Beads

(Addition)

Stops and starts should, if necessary, be ground and visible defects and high points shall be removed by grinding before a further weld run is deposited.

7.9 Identification of Welds

(Addition)



Accurate records to identify the work of each welder shall be maintained and a weld identification system providing each weld with a unique identification number shall be submitted.

Traceability of welder/s to number of passes and side of weld shall be carried out by low sulfur, halogen free weatherproof chalk/paint.

7.10 Preheat, Interpass Temperature, Postheat, and PWHT

(New)

7.10.1 (New) General

Preheat shall be applied and measured at 75mm either side of the weld joint edge/toe.

Preheating shall be applied by gas or electrical equipment. Induction heating is preferred for main pipeline welding and is mandatory for main line welding of pipe diameters greater than 500mm (20 inch).

Welding or cutting torches shall not be used for preheating.

Preheating shall be applied uniformly on both sides of the joint preparation around the entire periphery.

Interpass temperature checks shall be made during welding.

7.10.2 (New) Requirements

The minimum preheat shall be 50°C when the steel surface temperature is below 5°C or if moisture is present.

For grades with SMYS 415 (X60) or higher, a minimum preheat temperature shall be 100°C unless more preheat is required by the approved WPS.

For the application of either preheat or post-weld heat treatment by induction heating, the equipment and the procedure to be used shall be approved by the Contractor/Company.

In particular, the Fabricator shall demonstrate to the satisfaction of the Contractor/Company that heating rates and required temperatures can be properly controlled and that adequate precautions have been taken against overheating.

7.10.3 (New) Post-Weld Heat Treatment

The minimum number of thermocouples to be used shall be three (3). These shall be equally spaced around the weld circumference 25mm from the weld to ensure that the heated circumferential band will extend at least 25mm beyond the weld on either side.

A temperature recording chart shall be used for each PWHT cycle. Thermocouples and recorders shall have valid certificates of calibration.

For repairs done after PWHT, the repair welding procedure shall be qualified using PWHT simulated conditions.

PWHT of field welds shall be in line with AWS D10.10 and Contractor/Company approved post weld heat treatment procedure.

7.11 (New) Weld Separation

The minimum allowable distance between girth welds shall be $D/2$ or 250mm, whichever is the larger. There shall be no more than three girth welds in any 12 m length of pipeline.

Welds to branch connections shall be at least 100mm from any girth weld. The minimum distance between any adjacent welds other than two girth welds shall be the larger of $4t$ or 50 mm.

7.12 (New) Weld Interruption

Interruption of welding should be avoided. Where interruption is unavoidable, a minimum of three passes or one third of the joint thickness, whichever is greater, shall have been deposited. The weld shall be wrapped in a dry & heat-resisting thermal insulating blanket with a waterproof backing and shall be cooled at a slow uniform rate. On resumption of welding, any preheat requirements specified in the approved WPS shall be applied.



Weld Joints which are not part of hydro test, golden welds and weld repairs shall be completed in one cycle without weld interruption

7.13 (New) Weld Finishing

Welds shall be left as welded and shall not be treated with a flame torch or other mechanical means to change their appearance other than cleaning and dressing operations specified in the WPS. Welds shall not be peened.

7.14 (New) Fillet Welds and Branch Welds

All fillet welds shall be made using the SMAW process with basic low-hydrogen electrodes and/or with low hydrogen welding processes. The welds shall be multipass made in the vertical up direction with a flat or convex profile.

All branch welds shall be made using the SMAW process with basic low-hydrogen electrodes and/or low hydrogen welding processes except for root. GTAW shall be used for first two passes for branch ≤ 2 inch diameter and minimum one pass over 2 inch.

The branch weld profile shall ensure complete welding penetration. Partially welded branch welds shall not be acceptable unless approved by Contractor/Company.

7.15 (New) Back Welding

Back welding shall not be acceptable unless approved by Company. Back welding may be proposed if service is non-sour. In case, back welding is permitted, that shall be done using the same procedure that is used for the joint with fill and cap pass parameters.

8.0 INSPECTION AND TESTING OF PRODUCTION WELDS

8.2 Methods of Inspection

(Addition)

UT operators shall undergo demonstration test using the approved procedure.

The full circumference of pipeline butt welds and any other butt weld connections shall be examined by 100% Digital radiography or 100% mechanized/automatic ultrasonic testing (AUT). For wall thickness above 25mm (1 in), AUT is the preferred NDT technique.

Welds made using GMAW for any pass shall be inspected with automated ultrasonic testing (AUT).

All attachment welds to the pipe surface and all set-on branch fitting connection welds shall be subjected by 100% MT (i.e. complete length of every weld).

For offsite fabrication of pipeline spool pieces and the welding of fittings, there shall be a minimum delay between completion of welding and NDT of 24 hours. For all field welding with cellulosic electrodes, there shall be a minimum delay between completion of welding and NDT of at least 12 hours.

Coating or wrapping of a welded joint shall not begin until the weld NDT interpretation has been completed.

For tie-in joints, where the double wall, single image technique is employed, gamma radiography can be substituted for X-ray radiography provided it is supplemented with recordable ultrasonic testing.

For welds that will not be subjected to hydrotesting i.e. "golden" welds, both radiography and ultrasonic examination shall be carried out. With the agreement of the Contractor/Company, radiography may be waived if AUT is used.

Where RT is performed, it shall be Digital/computerised Radiography. Contractor/Company shall approve any other proposed Radiography techniques from OQ AVL if any.

8.3 Qualification of Inspection Personnel

(Addition) Qualification of NDE personnel shall also be meeting the requirements of OQ standard 03.01.15.



8.4 Certification of NDT Personnel

(Addition) In addition to the requirements stated in API Standard 1104, certification of NDE personnel shall also be meeting the requirements of OQ standard 03.01.15.

8.5 (New) Extent of NDE Inspection and Testing

The extent of inspection of completed welds shall be as per below Table.

Inspected Item	NDT Requirement (Refer Section 8.2 of this specification)			
	Visual	RT (Note-1)	UT (Note-1)	MT/PT
Field butt welds	100%	100% (Note-2)	(Note-2)	(Note-3)
Field Tie-in welds and Golden joints	100%	100%	100%	100%
Repaired areas in butt welds	100%	100%	100%	100%
Branch connections and fillet welds	100%	--	If practical	100%
Pipe-cut back, and lamination checks prior to welding attachments or fittings	100%	--	100%	100%
Field bevels	100%	--	--	100%
Following removal of arc strikes and crater cracks, (see Section 7.2 of this specification)	100%	--	--	100%
Notes:				
1. Digital/Computerized RT and Automatic UT.				
2. Mechanized or Automatic UT can be used to substitute RT.				
3. Required Percentage to be agreed by Contractor/Company.				

9.0 Acceptance Standards for NDT

9.3 Radiographic Testing

9.3.1 Inadequate Penetration Without High-Low (IP)

(Addition) This condition is unacceptable for sour service if the individual flaw size is greater than 10mm and cumulative length is more than 20mm in any 300mm length of weld.

9.3.2 Inadequate Penetration Due to High-Low (IPD)

(Addition) This condition is unacceptable for sour service if the individual flaw size is greater than 10mm and cumulative length is more than 20 mm in any 300 mm length of weld.

9.3.3 Inadequate Cross-Penetration (ICP)

(Addition) This condition is unacceptable for sour service if the individual flaw size is greater than 10mm and cumulative length is more than 20mm in any 300mm length of weld.

9.3.4 Incomplete Fusion (IF)

(Addition) This condition is unacceptable for sour service if the individual flaw size is greater than 10mm and cumulative length is more than 20mm in any 300mm length of weld.

9.3.5 Incomplete Fusion Due to Cold Lap (IFD)

(Addition) Areas of IFD which are separated by a distance not exceeding the length of the smaller indication shall be treated as a single IFD.

9.3.8 Slag Inclusions

9.3.8.1 General

(Addition) Copper inclusions shall not be acceptable.

9.3.10 Cracks

(Substitution) Cracks of any type shall be unacceptable.

9.3.14 (New) Excess Reinforcement and Penetration



Weld reinforcement, when measured from the adjacent parent material surface, shall not exceed the following values:

Wall Thickness (mm)	External weld reinforcement (mm)
6.4 and under	2.0
6.4 - 12.7	3.0
Over 12.7	3.5

Internal protrusion of the weld root shall not exceed 2.0mm for pipe thicknesses up to 12mm and 3.0mm for pipe thicknesses above 12 mm. When measuring internal protrusion, the line of the pipe bore outside the HAZ should be taken as the reference. Local profile changes adjacent to the fusion line should be discounted. For PE lined pipelines maximum internal protrusion shall be greater than 1.6mm.

9.6 Ultrasonic Testing

(Addition)

Where Ultrasonic Testing (UT) is stated, that means Automated UT.

9.6.2 Acceptance Standards

9.6.2.1 General

(Substitution) Replace “should” with “shall”.

(Addition)

The general (workmanship) AUT acceptance criteria stated below apply to pipelines of wall thickness ≥ 12 mm and are equivalent to the radiographic acceptance criteria stated in clause 9.3 of this specification and API STD 1104. The indication sizes are stated as measured dimensions and are based on a measurement uncertainty of 1.5 mm for both height and length. This uncertainty is the maximum permitted for any AUT system, which shall be established by historical data and performance trials.

For pipelines with wall thickness < 12 mm, the AUT acceptance criteria shall be subject to the agreement with Company.

As a rule of thumb, any indication signifying a crack or copper inclusion is not acceptable. Also, Visually apparent linear defects (i.e. lack of fusion) on, or adjacent to, the external weld cap of a depth greater than 1 mm are unacceptable.

The interaction rules for defects and flaw characterization in accordance with BS 7910 Figure 9 shall be applied.

(Substitution)

9.6.2.2 Linear Surface (LS) Indications

Defined as indication lies within 2 mm of the inner or outer surface. Indications shall be considered defects if any of the following conditions exist:

- Height < 3.0 mm: Length: Wall thickness or 25 mm, whichever is less
- Height > 3.0 mm: Not acceptable.

9.6.2.3 Linear Buried (LB) Indications

Defined as indications not within 2 mm of the inner or outer surface. Indications shall be considered defects if any of the following conditions exist:

- Height < 3.0 mm: Length: 50 mm or 2 x wall thickness, whichever is less
- Height > 3.0 mm < 5 mm or 0.25 t, whichever is less: Length: 12.5 mm.
- Height > 5 mm or 0.25t, whichever is less: Not acceptable.

9.6.2.8 Accumulation

The maximum allowable accumulated length of reportable indications in any 300 mm of weld shall be 100 mm or 3 x wall thickness, whichever is less.



The maximum allowable accumulated length of reportable indications in any weld is 12% of weld length.

(New)

9.6.2.9 Gas Cluster

Gas clusters with Height > 3 mm or length > 25 mm is not acceptable.

9.9 (New) NDT Evaluation Report

An evaluation report shall be made stating the identification number of each weld inspected and the name of the welder/operator together with the description of the inspection method and, if applicable, the reason for rejection of the weld.

9.10 (New) Welder Performance Records

The Fabricator shall maintain an accurate record of the performance of each welder which shall show the repair rate. The repair rate should be expressed as a percentage of repaired welds over the total number of welds produce. The Contractor/Company shall have the right to remove any welder from the job if his performance is considered to be of an unacceptable standard.

9.11 (New) Assessment of Adjacent Pipe Material

Radiographic indications showing that the pipe material next to the weld is defective or has been damaged in any way (e.g. arc burns, mechanical damage, weld beads, defects in the longitudinal seam of longitudinally welded pipe, etc.) shall be reason to reject the weld.

10.0 REPAIR AND REMOVAL OF DEFECTS

10.2 Repair Requirements

10.2.1 Company Authorisation Requirements

(Addition)

Defects shall not be repaired in any part of the weld without prior permission from Contractor/Company. Repair welding shall be offered for Contractor/Company witness.

Type of defects, method of defect removal, and a schematic location/depth of the repair shall be stated in the method statement for the repairs by the Fabricator and that shall be approved by Contractor/Company

Single run repairs and root sealing runs shall not be permitted.

Welds on material with SMYS < 360 MPa may be repaired twice. Other materials shall be repaired only once.

Repair welds joints shall be completed in one cycle without weld interruption.

Repair weld grooves shall be visually and magnetic particle inspected prior to re-welding to ensure complete removal of the defect.

The repair shall have 150°C preheat for materials with SMYS ≥ 415 MPa (i.e. API 5L grade ≥X60)

The total repair length shall not exceed 40% of the total weld length.

For partial penetration repairs, the maximum length of a single repair portion shall be 30% of the total weld length. For full penetration repairs, the maximum length of a single repair portion shall be 20% of the total weld length. Groove taper shall be included in the measurements.

The joint wise repair rate shall not exceed 2%.

If post weld heat treatment is specified, this shall be applied to the whole welded joint (Local PWHT is not acceptable).

NDT of original weld shall be applied to complete weld after repairing and shall meet requirements of Section 9 of API Standard 1104 and this specification.



For grade L 415 (X60) and above, repair weld procedure qualification is required for all types of repair in accordance with 10.3.

10.3 Repair Procedure

10.3.2 b) Repair procedure shall be qualified for each process.

10.3.6 Testing of Repair Welds

10.3.6.1 General

(Addition) Add in second paragraph the below:

Table-11 of API Standard 1104 shall be amended considering additional testing requirements stated in Section 10.3.6.3 and 10.3.6.4. NDT as required for original welding procedure shall be conducted on the repair procedure.

10.3.6.3 Charpy Impact Tests

10.3.6.3.1 General

(Substitution)

All repair qualifications require impact testing similar to original weld procedure. Refer to Section 5.6.7 of this specification for further information and requirements.

10.3.6.4 Hardness Tests

Change title of Section 10.3.6.4 to below:

10.3.6.4 Macroscopic Examination and Hardness Testing

(Addition) All repairs qualifications requires Macroscopic Examination and Hardness Testing similar to original weld procedure. Refer to Section 5.6.6 of this specification for further information and requirements with the exception that hardness measuring points for repair procedure shall be as per the requirements in API Standard 1104, Figures 22 to 27.

Acceptance criteria for repair welding hardness and macro examination testing shall be similar to the original weld procedure. Refer to Section 5.6.6.3 of this specification for further information and requirements.

11.0 PROCEDURES FOR NON-DESTRUCTIVE TESTING (NDT)

11.1 Radiographic Test Methods

11.1.1 General

(Addition)

Digital Radiography on all pipeline girth welds shall be the utilised method. Utilization of other RT methods shall need approval of Contractor/Company. Fabricator shall qualify a digital RT procedure specific to the project. The procedure shall be witnessed and approved prior to implementation and Fabricator shall be responsible for all qualification process. For the procedure qualification, Fabricator shall introduce artificial defects on a test specimen (or shall use a specimen with known weld defects) and conduct test with conventional RT and Digital RT. The sensitivity and sharpness shall conform to applicable industry standards. The Digital RT procedure shall include a calibration frequency which shall describe minimum requirement as agreed by Contractor/Company.

Fabricator may use any suitable hardware/software to execute the activity. However, the following technical requirements are stipulated as a minimum:

- The Computerized Radiography Scanner shall be BAM (Federal Institute for Material and Research based in Berlin, Germany) certified and shall be suitable to be used with both Isotopes and X-ray source. The scanner shall have resolution capability of 17 micron, 25 micron, 50 micron and 100 micron.
- The software shall comply to ASTM E2339 standard requirements (DICONDE). The software shall have feature for image optimization, enhancement and adjusting the brightness and contrast settings to obtain the sharpest image as well as capability for report generating.
- Fabricator shall use high quality radiographic imaging plates sufficient to cover RT of a pipeline.



- The final handing over of RT images shall be in readable formats like JPEG etc. and the original software with licence shall be supplied with the RT images.

If any practical difficulties in carrying out the Digital RT for weld joints, the RT may be performed with conventional radiography subject to Contractor/Company approval and it shall be digitalized as soft image in DICOM format along with report.

Conventional RT shall be carried out with approved procedure and that shall be a project specific procedure.

The Fabricator shall use Digitizer to convert the Conventional radiographic films to Digital format. The digitizer shall handle the full density range ($D = 0$ up to $4.70 D$) in one working range with the requested contrast sensitivity. It shall meet the requirements for class DS film digitizers, according to ISO14096-2 classification confirmed by BAM

(Addition) Radiographic testing shall be conducted using X-ray equipment, If the use of X-ray equipment is impracticable, Iridium 192, Ytterbium 169 or Selenium 75 may be used subject to approval by Contractor/Company. Other sources of gamma rays are not permitted.

Internal sources, (crawler units), shall be employed for the radiography of all field butt joints in line pipes of 8 inches NPS and over, including repair welds where accessible. In cases where the sources cannot be placed inside the pipe, the double-wall/single-image technique shall be applied for diameters over 3 inches NPS and double wall / double-image technique for diameters of 3 inches NPS and below. Double wall Single image (DWSI) techniques shall not be used for diameters below 3 inches.

11.1.2 Details of Procedure

11.1.2.2 Film Radiography

(Addition)

For use of film radiography in production, radiographs shall be made using slow film types defined in below Table. Other film types are subject to Contractor/Company approval.

Film Type	Speed	Contrast	Grain	Equivalent to:
1	Slow	Very High	Very Fine	Kodak Industrex M Kodak Industrex TMX Kodak Industrex T Agfa D2 Agfa D4 Fuji 50
2	Medium	High	Fine	Kodak Industrex AX Kodak Industrex AA Agfa D5 Agfa D7 Fuji 100

11.1.4 Type of Image Quality Indicator (IQI)

(Addition) Wire type IQIs (image quality indicators, IQIs) in accordance with ISO 19232-1 shall be used.

11.1.9 Production Radiography

(Addition)

If cellulose electrodes are used, radiographs shall be taken after 12 hours of weld completion. If a low hydrogen process is used, radiographs shall be taken after 24 hours of weld completion.

11.1.10 Identification of Radiographic Images

(Addition)

On pipe diameters over 3 inches, a tape measure with lead numbers every 100mm shall be placed adjacent to the weld. The zero point shall be on the top of the pipe and the divisions shall run clockwise



in ascending order, viewed in the direction of pipeline laying progress. On diameters less than 3 inches, each shot shall be designated by a lead letter placed on the pipe, i.e. A, B, C.

Where the weld has been dressed, markers in a form to be approved by the Contractor/Company shall be placed alongside the weld, but clear of the heat affected zone, to identify its position.

If sufficient space is available, the pipeline reference weld number and section number shall be included in the radiograph identification.

Each weld shall be marked using indelible material, to provide reference points for the accurate relocation of the position of each radiograph.

11.1.12 Film Density

11.1.12.1 General

(Addition)

For gamma rays, film shall be exposed so that the density through the weld metal is not less than 2.0.

11.1.12.4 Film Processing

(Substitution)

Film or other images shall be processed, so that the images are interpretable for the retention period in the Contract.

11.4 Ultrasonic Test Methods

11.4.1 General

(Addition)

The validity range of a procedure demonstrated on a pipe with diameter (D) and thickness (t) shall be the following:

- Diameter (D): From 0.9D up to 1.5D
- Thickness (t): From $t/1.25$ up to $t/0.75$

Ultrasonic testing shall not be performed on pipe thickness below 7mm.

AUT procedure performance demonstration testing shall be witnessed by Contractor/Company. AUT calibration block validation shall be done by third party (such as DNV, Applus Velosi or any other Company's approved agency).

Qualification of AUT systems, procedures and operators shall be in accordance DNV OS-F 101, Appendix E. The use of alternative qualification standard system for AUT is subjected to Contractor /Company Approval.

All AUT reports shall be reviewed and endorsed by Level III.

12.0 MECHANIZED WELDING WITH FILLER METAL ADDITIONS

12.1 Acceptable Processes

(Substitution)

item d): Delete the word "without".

item f): Delete the word "Semi-automatic"

(Addition)

Mechanized (automatic) 2G or 5G welding equipment should be operated in conjunction with data logging facilities capable of recording the essential variables associated with the arc including wire feed speeds and travel speeds. The equipment shall record all parameters for each pass of every weld at a minimum rate of once per 10 degree of angular rotation and shall indicate the angular position of each measurement.

Each mechanised (automatic) welding station shall be demonstrated fully operational before it is employed to weld any joints that will be incorporated into the pipeline.



FCAW arc welding process is unacceptable.

12.2 Procedure Qualification

(Substitution)

Delete reference to “semi-automatic” in 2nd paragraph.

(Addition)

Three consecutive complete qualification welds shall be made between either complete pipe joint lengths or nipples as detailed in Section 5.5 of this specification, following all the details of the WPS under conditions which simulate those of the site production location. All three welds shall be non-destructively tested and shall meet the requirements of Section 9 of API Standard 1104 and this specification and at least one weld shall be destructively tested in accordance with Section 5.6 of this specification.

12.4 Welding Procedure Specification

12.4.2.2 The contract materials to which the procedure applies shall be identified. Grouping of materials of different pipe manufacturers, supply condition, diameter, wall thickness or steel specification/grade is not allowed

12.4.2.3 Procedures shall be qualified for each combination of diameter and nominal wall thickness using project materials.

The numbers of beads required for each project pipe thickness and the machine type/model used for each bead shall be clearly identified

12.4.2.6 Filler Metal and Flux

(Addition)

Details of the filler metal/flux manufacturer(s)/brand name(s) shall be given together with a sketch showing the location, number and deposition sequence of each weld bead.

12.4.2.8 Electrical Characteristics, Travel Speed, and Heat Input

(Addition)

For pulsed arc welding the pulsing characteristics, including the frequency, amplitude, shape, base level, delay and crater fill, shall be specified.

12.4.2.9 Refer 5.3.2.8

12.4.2.11 Refer 5.3.2.11

12.4.2.12 Refer 5.3.2.13

12.5 Essential Variables

12.5.2 Essential Variables Categories

(Addition)

With reference to the welding variables sub-sections column in Table-20 of API Standard 1104, the changes requiring requalification shall also be as per the below in addition to those highlighted in Table-20 of API Standard 1104. This is applicable to both Category I (standard WPS) and Category II (WPS with hardness and/or toughness).

12.5.2.2 Base Materials

(Addition)

- Unless otherwise agreed with Contractor/Company, for main line welding, the welding procedure shall be qualified on project material.
- Where SMYS of material specified as $\geq$ ISO 3183 L415 (API 5L X60), then each combination requires qualification including manufacturer.



- For sour service, any change in material grades with SMYS $\geq$ 415Mpa.
- A change in pipe manufacturing process and/or heat treatment condition.

12.5.2.6 Filler metal

(Addition)

The requirements stated in Section 4.2.2 & 5.4.2.6 of this specification shall also be applied.

(New)

12.5.2.14 **(New)** Number and Sequence of Weld Beads

A change in the minimum number of the weld beads deposited or the sequence of deposition shall constitute an essential variable.

12.5.2.15 **(New)** Automatic Welding Equipment Parameter

Any change in power source, controller make, model, any change in number of torches, wires, any change in weaving/oscillation.

12.6 Testing of Welded Joints – Butt Welds

(Addition)

The additional testing requirements stated in Section 5.6 (and its sub-clauses) of this specification shall also be applied.

12.7 Qualification of Welding Operators

12.7.1 General

(Substitution)

Delete reference to “semi-automatic”.

12.7.6 Changes Requiring Requalification

(Addition)

- c) Any change from filler metal AWS classification, specification, diameters, manufacturer trade and brand name.

12.9 Inspection and Testing of Production Welds

(Substitution)

Production welds shall be inspected and tested in accordance with Section 8 of API Standard 1104 and this specification.

12.10 Acceptance Standards for Non-Destructive Testing

(Substitution)

The acceptance standards for non-destructive testing shall be in accordance with Section 9 of API Standard 1104 and this specification.

12.11 Repair and Removal of Defects

(Substitution)

Repair and removal of defects shall be in accordance with Section 10 of of API Standard 1104 and this specification.

12.12 Radiographic Testing

(Substitution)

Radiographic testing shall be in accordance with Section 11.1 of API Standard 1104 and this specification.



12.13 Ultrasonic Testing

(Substitution)

Ultrasonic testing shall be in accordance with Section 11.4 of API Standard 1104 and this specification. Automatic UT shall be performed on automated welded joints.

13.0 (New) Documentation

13.1 General

The Fabricator shall maintain a record system which ensures weld traceability. The Fabricator shall be responsible for compiling the following document packages which shall be submitted to the Contractor/Company upon completion of the works:

(a)

- Certificate of Conformity
- Copy of approved Welding Procedure Register
- Copies of approved WPSs
- Copies of approved repair WPSs
- Copies of all supporting PQRs
- List of approved welders and their identification
- Copies of company endorsed Welders Qualification Cards
- List of approved NDT technician/ operators
- Copies of NDT technician/operator qualification certificates
- List of Company-approved deviations to the Code and this specification
- Copies of Company-approved deviations to the Code or this specification
- List of consumable batch certificates
- Copies of consumable batch certificates and GMAW filler material batch test certificates
- List of materials certificates
- Copies of materials certificates
- List of test equipment
- Copies of calibration certificates

(b)

- List of as-built drawings
- As built drawings showing unique weld number
- Copies of weld history sheets which shall show for each weld
 - weld number
 - isometric and line number
 - material specifications and identification
 - the WPS employed
 - the welders' identity symbols
 - date welded
 - visual inspection disposition
- NDT reports where applicable (to be attached to weld history sheet)
- type of repair, if applicable, and WPS
- NDT reports for repairs (to be attached to weld history sheet)
- PWHT if applicable (chart to be attached to weld history sheet)
- batch number of consumables employed
- Radiographs – indexed and stored in a fireproof container
- AUT & DRT soft copies
- Software for AUT & DRT List of site test records
- Copies of site test records
- List of non-conformances/corrective actions issued during external or internal audits
- Copies of non-conformances/corrective actions issued during external or internal audits.



Annex A: Alternative Acceptance Standards for Girth Welds

The use of Annex A shall be need Contractor/Company Approval.

Annex B: In-Service Welding

This Annex is not applicable to the scope of this specification. Delete this Annex in its entirety.



V. (New) References

API	
Specification for Line Pipe	API 5L
ASTM	
Standard Test Methods and Definitions for Mechanical Testing of Steel Products	ASTM A370
Standard Test Methods for Vickers Hardness and Knoop Hardness of Metallic Materials	ASTM E92
Standard Practice for Digital Imaging and Communication in Non-destructive Evaluation (DICONDE)	ASTM E2339
ASME	
Pipeline Transportation Systems for Liquids and Slurries	ASME B31.4
Gas Transmission and Distribution Piping Systems	ASME B31.8
Hydrogen Piping and Pipelines	ASME B31.12
AWS	
Recommended Practices for Local Heating of Welds in Piping and Tubing	AWS D10.10
Welding Consumables — Gases and Gas Mixtures for Fusion Welding and Allied Processes	AWS 5.32
EFC	
Guidelines on Materials Requirements for Carbon and Low Alloy Steels for H ₂ S-Containing Environments in Oil and Gas Production	EFC 16
EN	
Metallic Products — Types of Inspection Document	EN 10204
ISO	
Steel and steel products — Inspection documents	ISO 10474
Welding consumables — Gases and gas mixtures for fusion welding and allied processes	ISO 14175
Petroleum and natural gas industries — Steel pipe for pipeline transportation systems	ISO 3183
Petroleum and natural gas industries — Pipeline transportation systems	ISO 13623
Non-destructive testing — Image quality of radiographs — Part 1: Determination of the image quality value using wire-type image quality indicators	ISO 19232-1
Petroleum and natural gas industries — Materials for use in H ₂ S-containing environments in oil and gas production	ISO 15156-series
Metallic materials — Charpy pendulum impact test	ISO 148-series
Destructive tests on welds in metallic materials — Longitudinal tensile test on weld metal in fusion welded joints	ISO 5178
Metallic materials — Tensile testing — Part 2: Method of test at elevated temperature	ISO 6892-2
Corrosion of metals and alloys — Stress corrosion testing — Part 2: Preparation and use of bent-beam specimens	ISO 7539-2
Non-destructive testing — Qualification of radiographic film digitisation systems — Part 2: Minimum requirements	ISO 14096-2
NACE	
Materials for use in H ₂ S-containing environments in oil and gas production	NACE MR 0175
Four-Point Bend Testing of Materials for Oil and Gas Applications	NACE TM 0316





Roles and Responsibilities

The Project CoE Lead Engineering have the responsibility to approve this document.

The Project CoE Mechanical Team Lead will be responsible to ensure this document is updated and rolled-out.

The Project CoE Mechanical Technical Authority will be responsible to sign any deviation to this specification.



Abbreviations

- **API:** American Petroleum Institute
- **ASME:** American Society of Mechanical Engineers
- **ASTM:** American Society for Testing and Materials
- **AWS:** American Welding Society
- **EFC:** European Federation of Corrosion
- **EN:** European Norm
- **ISO:** International Standards Organisation
- **NACE:** National Association of Corrosion Engineers International



Appendix 1 - USER FEEDBACK PAGE

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DOCUMENT INFORMATION

Title	Welding and NDE of Pipelines-Specification (Amend API Standard 1104)
Document Code	03.01.10-Welding_and NDE_of_Pipelines-Specification (Amend API Standard 1104)
Purpose	To define the minimum technical requirements of Pipeline Welding for any OQ Project.
Audience	Project team, Contractors and Vendors
Category	Governance;
Subcategory	Projects/ CoE
Effective Date	20/11/2021
Review Date	19/11/2023
Document Advisor	Projects COE Quality Team Lead
Approving Authority	Projects COE Leader

RELATED AND SUPPORTING DOCUMENTS

Policy	N/A
Policy Manual	N/A
Process	N/A
Procedures	N/A
Related Documents and Forms	N/A



DOCUMENT APPROVALS		
Authorized Approver	Date	Signature(s)
VP, Project CoE	10/03/2022	