



**DOMESTIC PETROLEUM OPERATING BRANCH -
PETROVIETNAM EXPLORATION PRODUCTION
CORPORATION LIMITED
(PVEP-POC)**

PROJECT

**DAI HUNG NAM PROJECT, BLOCK 05.1(a)
OFFSHORE VIETNAM**

PHASE

FRONT END ENGINEERING DESIGN (FEED)

**SPECIFICATION FOR OFFSHORE PIPELINE FIELD
WELDING, WELD REPAIR AND NDT**

0

29 Nov 24

Approved for Construction

N. SHAHNAZ

Rev.

Date

Description

Approved by RNZ

Approved by PVEP-POC

Petrofac



RNZ



CONTRACTOR:

RNZ INTEGRATED (M) SDN BHD

SUBCONTRACTOR:

PVENGINEERING CONSULTANCY JSC

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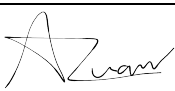

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1	C0	Issued for Review	21 Aug 24
2	D0	Approved for Design	20 Sep 24
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**SPECIFICATION FOR OFFSHORE PIPELINE FIELD
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1. PROJECT OVERVIEW

1.1 INTRODUCTION

Dai Hung Nam (DHN) area is located in the southern part of Dai Hung oil field of Block 05-1(a), approximately 250 km from the coastline of the South-Eastern Vietnam and is situated in a water depth of 110 m (average). Block 05-1(a) has been operated by PVEP since 2003. The center of DHN is located approximately 3.5 km from the existing WHP-DH02 and 7.5 km from the current location of the FPU.

The location map of Block 05-1(a) is as hereunder in Figure 1.1.1.

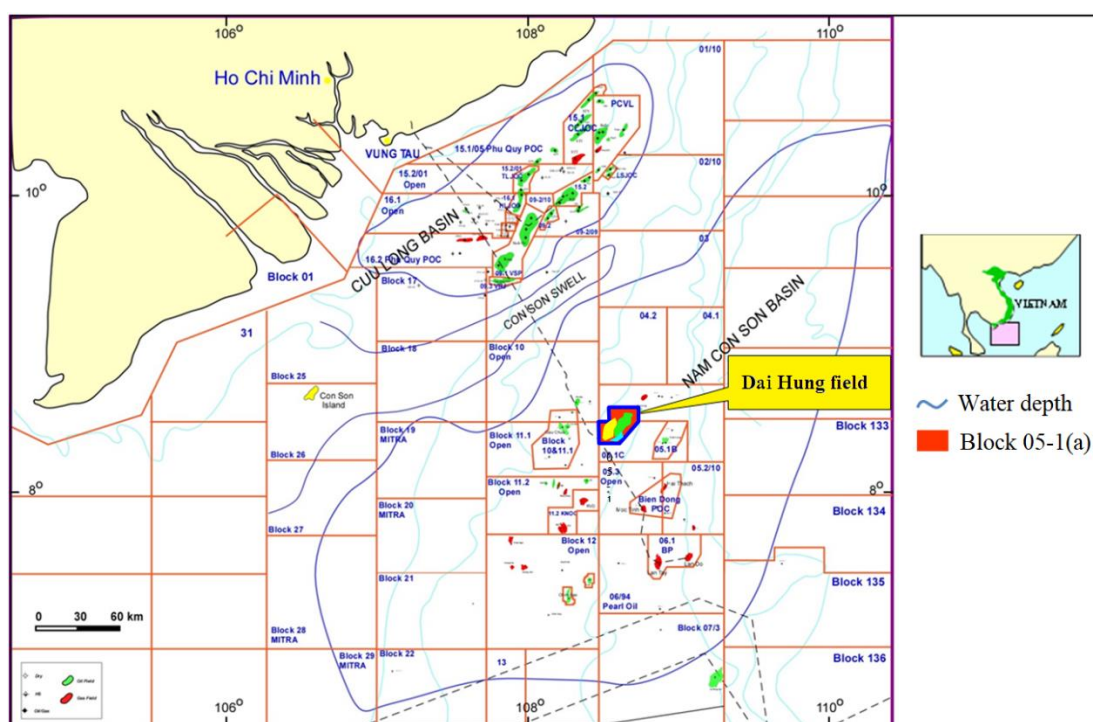


Figure 1.1.1: Block 05-1(a) Location

1.2 BLOCK 05-1(A) EXISTING FACILITIES

The block facilities currently comprise of: Floating Production Unit Dai Hung (FPU), subsea wells, flowlines, mid depth buoy, calm buoy, and a 6" oil export pipeline that routes product liquid from the FPU to the FSO. The Wellhead Platform DH02 (WHP-DH02) is located in southwest direction of FPU at a distance of about 5km, dual 6" subsea export pipeline that transports the liquid from WHP-DH02 to FPU for further processing. Dai Hung gas gathering system with a pipeline length of approximately 20 km to transport gas from WHP-DH02 to BK-TNG of Vietsovpetro Joint Venture (VSP) (Figure 1.2.1); and the wellhead platform DH01 (WHP-DH01) is located in northeast direction of FPU at a distance of about 2.5 km, 10" subsea export pipeline that transport the liquid from WHP-DH01 to FPU for further processing, 6" fuel gas pipeline to supply fuel gas to FPU, 8" water injection pipeline for supplying water injection from FPU to WHP-DH01 and 12" export gas to BK-TNK.

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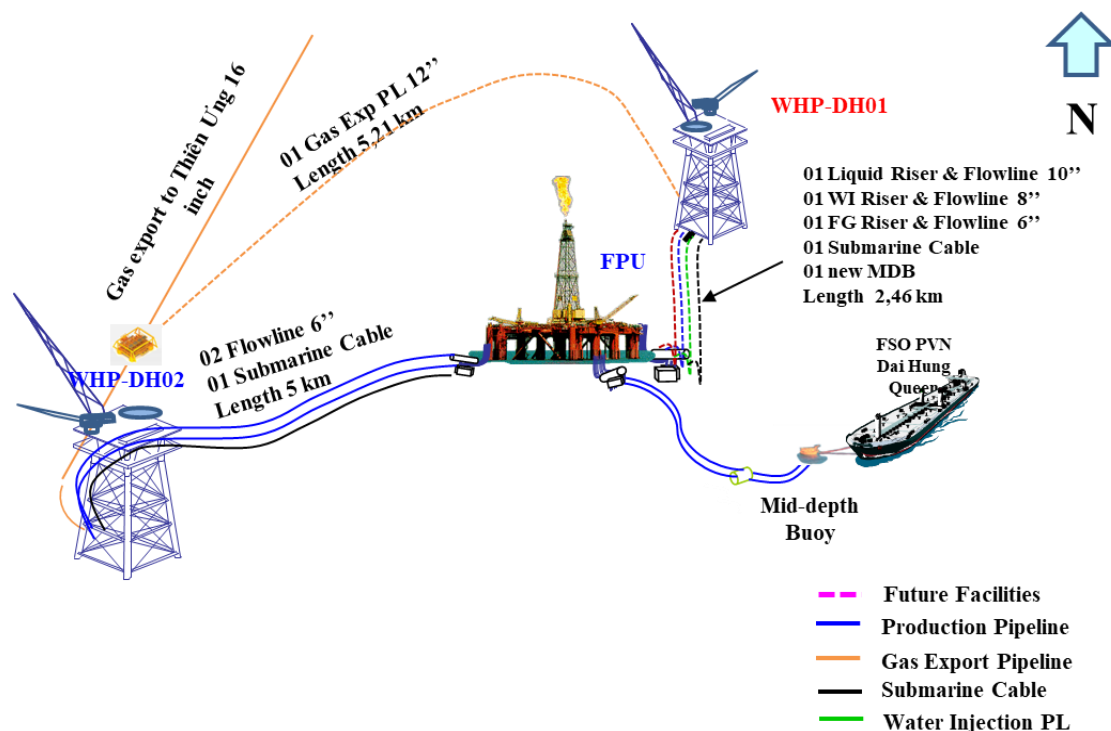


Figure 1.2.1: Existing Dai Hung Field Facilities in 2024

1.3 DAI HUNG NAM DEVELOPMENT SCHEME

The field facilities in Dai Hung Nam Field Development are as follows:

- New unmanned wellhead platform WHP-DHN located near WHP-DH02. WHP-DHN will be designed with 11 well slots for drilling by jack-up rig. Full wellstream of WHP-DHN will be routed to a Production Separator (on WHP-DHN) then the separated liquid is transported to FPU for further processing, a separated associated gas is exported to BK-TNG.
- Infield Pipelines:
 - One liquid rigid pipeline, transporting separated liquid from WHP-DHN to FPU through subsea tie-in point of existing 10" liquid flowline from WHP-DH01 to FPU.
 - One gaslift rigid pipeline, transporting gaslift from WHP-DHN to WHP-DH02.
 - One export gas/source gas, transporting separated associated gas/source gas from WHP-DHN to subsea tie-in point of 16" existing export gas pipeline and via versa.
 - One water injection rigid pipeline, transporting water injection from FPU to WHP-DHN through subsea tie-in point of existing 8" water injection flowline from FPU to WHP-DH01.

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- Modification works on WHP-DH02, WHP-DH01 and FPU for connection and processing.

Scheme of Dai Hung Nam Field Development is presented as below.

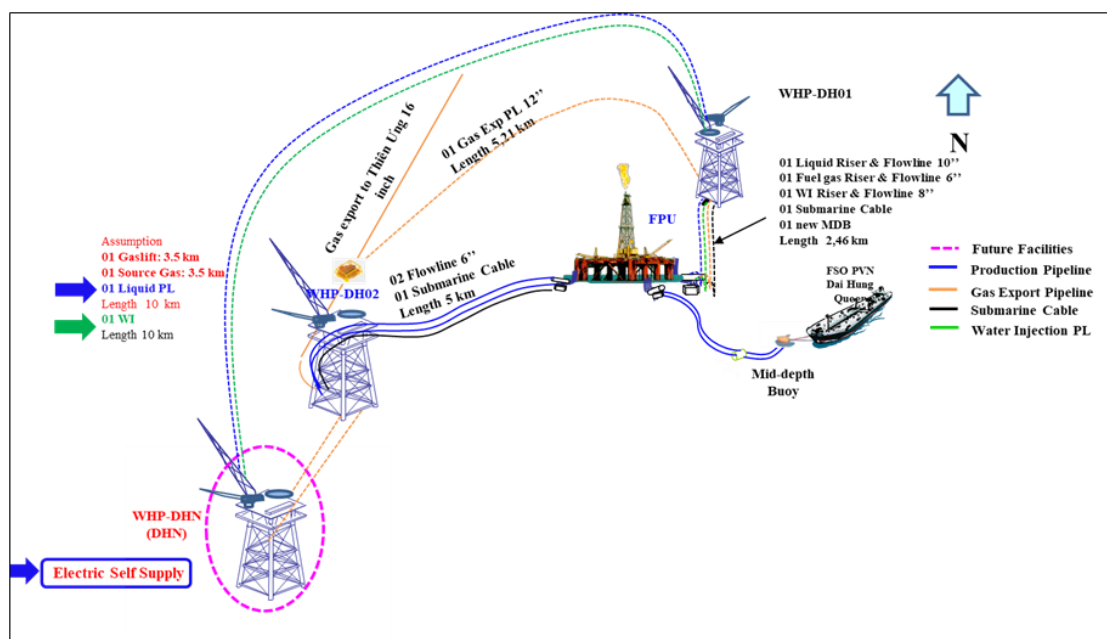


Figure 1.3.1: Dai Hung Nam Field Development Scheme

2. PURPOSE AND SCOPE

This specification establishes the minimum requirements for welding, examination, and testing of offshore pipelines. Unless otherwise specified in the contract documents, the requirements of API Standard 1104 shall apply. In addition to the requirements of API Standard 1104 (ASME B31.4 and ASME B31.8 if so specified), the supplemental requirements of this specification shall apply and take precedence.

3. DEFINITIONS AND ABBREVIATIONS

3.1 DEFINITIONS

PROJECT	Dai Hung Nam Project
CLIENT	Domestic Petroleum Operating Branch – PetroVietnam Exploration Production Corporation Limited (PVEP-POC)
CONTRACTOR	The company or consortium which is awarded any or all of the Engineering, Procurement, Construction and Installation for the project

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VENDOR/SUPPLIER/ MANUFACTURER	The entity which supplies any product/services/ system to the CLIENT against a purchase order issued by the CLIENT or its SUB-CONTRACTOR
PURCHASER	It is an entity belonging to the CLIENT or CONTRACTOR responsible to issue order for any product or services complete with all technical and commercial documents
CERTIFICATION AUTHORITY	The authority engaged by the CLIENT to review, appraise and certify the WORK in accordance with the applicable codes, standards and specifications
WORK	The goods and services provided to the CLIENT by the VENDOR/SUPPLIER/MANUFACTURER
THIRD PARTY INSPECTION (TPI)	The independent agency appointed by CLIENT and to perform, design appraisals and manufacturing surveillance activities at the Supplier's works with respect to the subject work on behalf of the CLIENT
SUB-VENDOR/ SUB- SUPPLIER	Sub-Vendor/Sub-Supplier to Vendor/ Supplier/ Manufacturer
EPC CONTRACTOR	The entity who are responsible for the entire project from engineering design and procurement of materials and equipment to construction, commissioning, and handover to the CLIENT

3.2 ABBREVIATIONS

API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing Materials
AUT	Automatic Ultrasonic Testing
AWS	American Welding Society
CTOD	Crack – Tip – Opening Displacement
D.C.	Direct Current

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DNV	Det Norske Veritas
EPC	Engineering, Procurement and Construction
FCAW	Flux-Cored Arc welding
GMAW	Gas Metal Arc Welding
GTAW	Gas Tungsten arc Welding
HAZ	Heat Affected Zone
HSE	Health, Safety and Environment
ID	Internal Diameter
IQI	Image Quality Indicators
ISO	International Organisation of Standardisation
ITP	Inspection and Test Plan
MPI	Magnetic Particle Inspection
MT	Magnetic Particle Testing
NDE	Non-Destructive Examination
NDT	Non-Destructive Testing
PQR	Procedure Qualification Record
PT	Liquid Penetrant Testing
PWHT	Post-Weld Heat Treatment
RMS	Root Mean Square
RT	Radiographic Testing
SMAW	Shielded Metal Arc Welding
T&I	Transportation and Installation
TCVN	Vietnamese Standards
UT	Ultrasonic Testing
WHP-DH01	Dai Hung 01 – Wellhead Platform
WHP-DH02	Dai Hung 02 – Wellhead Platform
WHP-DHN	Dai Hung Nam – Wellhead Platform
WPQ	Welding Procedure Qualification
WPQT	Welding Procedure Qualification Testing

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WPS

Welding Procedure Specification

4. UNIT OF MEASUREMENT

Unit of measurement will be applied the International System of Units (SI).

5. REFERENCE DOCUMENT, DRAWING, CODES AND STANDARDS

The following specifications shall be interpreted as the minimum requirements applicable to the subject work, and no statement contained in this Specification shall be construed as limiting the work to such minimum requirements. Any requirements stated herein which contravene related codes, standards or specifications shall immediately be brought to the attention of EPC CONTRACTOR/ CLIENT for resolution.

Where relevant Vietnamese national regulations exist, the requirements and recommendations shall apply together with the standards and codes referenced therein. These regulations may thus complement or amend the provisions of the present document.

5.1 VIETNAMESE STANDARDS

The following Vietnamese standards and regulations shall be applied in this Project Specification:

Vietnamese Standards (TCVN)	
TCVN 4606	Main Pipelines for Transporting Petroleum and Petroleum Products – Codes for Construction Check and Acceptance
TCVN 6475	Rules for the Classification and Technical Supervision of Subsea Pipeline Systems, 2017

5.2 PROJECT DOCUMENT

The following Project's documents shall be applied to the subject work:

DHF-00-A-P-0002	Dai Hung Field Development – Numbering System
DHF-00-A-P-0003	Vendor Data Instruction
DHF-00-A-P-0005	Vendor Quality Specification.
WHP-DHN-L-A-0001	Pipeline and Riser Design Basis
WHP-DHN-L-S-0001	Specification for Linepipes
WHP-DHN-L-S-0002	Specification for Pipeline Hot Induction Bends
WHP-DHN-L-S-0004	Specification for Pipeline Flanges and Fittings

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WHP-DHN-L-S-0005	Specification for Subsea Barred Tees and Piggable Wye
WHP-DHN-L-S-0008	Specification for Offshore Pipeline Installation

5.3 INTERNATIONAL CODES AND STANDARDS

The intended item in this Specification shall be in compliance with the following codes, standards, applicable laws, rules, regulations and requirements of the Regulatory Agencies, which have jurisdiction over the design, construction and operation of the pipeline. Latest revision of codes, standards and regulations shall be applied unless noted otherwise.

American Petroleum Institute (API)	
API SPEC 5L	Specification for Line Pipe, 2018
API Standard 1104	Welding of Pipelines and Related Facilities, 2021
API Standard 1107	Pipeline Maritime Welding Practices
API RP 1111	Design, Construction, Operation and Maintenance of Offshore Hydrocarbon Pipelines
API RP 582	Welding Guidelines for the Chemical, Oil and Gas Industries
American Society of Mechanical Engineers (ASME)	
ASME BPVC Section V	Nondestructive Examination, 2015
ASME BPVC Section IX	Welding & Brazing Qualifications, 2015
ASME Section II, Part C	Specification for Welding Rods, Electrodes and Filler Metals.
ASME B31.4	Gas Transmission and Distribution Piping System, 2019
ASME B31.8	Pipeline transportation systems for liquids and slurries, 2020
American Society of Non-Destructive Testing (ASNT)	
ASNT SNT-TC-1A	Recommended Practice for Non-Destructive Testing, 2020
American Society for Testing and Materials (ASTM)	
ASTM A370	Standard Test Method and Definitions for Mechanical Testing of Steel Products, 2020
ASTM E 2	Method of Preparation of Micrographs of Metals and

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	Alloys
ASTM E 3	Preparation of Metallographic Specimen
ASTM E 23	Test Methods for Notched Bar Impact Testing of Metallic Materials
ASTM E 92	Standard Test Method for Vickers Hardness of Metallic Materials
ASTM E 94	Standard Guide for Radiographic Examination
ASTM E 114	Standard Practice for Ultrasonic Pulse-Echo Straight Beam Examination by the Contact Method
ASTM E 384	Standard Test Method for Micro-indentation Hardness of Metals
ASTM E 709	Standard Guide for Magnetic Particle Testing
ASTM E 1961	Standard Practice for Mechanized Ultrasonic Examination of Girth Welds using Zonal Discrimination with Focused Search Units
American Welding Society (AWS)	
AWS A4.3	Standard Methods for Determination of the Diffusible Hydrogen Content of Martensitic, Bainitic and Ferritic Steel Held Metal Produced by Arc Welding
Det Norske Veritas (DNV)	
DNV-ST-F101	Submarine Pipeline Systems, 2021
International Standard Organization (ISO)	
ISO 1027	Radiographic Image Quality Indicators for Non-Destructive Testing – Principles and Identification
ISO 3183	Petroleum and Natural Gas Industries – Steel Pipe for Pipeline Transportation System
ISO 8501-1	Preparation of Steel Substrates before application of Paints and related products - Visual Assessment of Surface Cleanliness
ISO 9712	Non-Destructive Testing – Qualification and Certification of NDT Personnel
ISO 9001	Quality Management Systems – Requirements, 2015

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6. ORDER OF PRECEDENCE

In the event of conflict between this Specification, and any other Specification, Datasheet, Code or Regulation, **VENDOR/SUPPLIER/MANUFACTURER** shall inform in writing and receive written clarification from **CLIENT** before proceeding with the work.

The order of precedence shall be:

- a) Mandatory Local Laws and Regulations
- b) Enquiry / Purchase Order
- c) Project Specific Data Sheets
- d) This Specification
- e) **CLIENT** General Specifications
- f) National and International Codes and Standards

7. GENERAL REQUIREMENTS

7.1 LANGUAGE

The content, references, attachments and any supplementary information in this Specification shall be given in English, unless another language is required.

7.2 DESIGN LIFE

The design life of Dai Hung Nam Project's pipeline systems shall be 20 years.

7.3 STATUTORY REQUIREMENTS

It is **VENDOR** responsibility to ensure that all Vietnamese (TCVN) standards and Local regulations are complied with during design, fabrication, testing and supply of the equipment.

VENDOR shall be responsible to ensure necessary submission of documents, coordination of any inspection, inter-action and getting approval of the equipment under his scope of supply from Vietnamese authorities wherever required.

8. HEALTH, SAFETY AND ENVIRONMENT

EPC CONTRACTOR/ CLIENT has HSE targets of no accidents or harm to people or environment. To achieve this goal, all work shall be completed in a safe manner, such that no harm can be caused to personnel and in such a way that the impact on the environment is minimized at all locations where the project related work is performed, including the **SUPPLIER's** facilities and the fabrication yard.

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9. QUALITY ASSURANCE AND QUALITY CONTROL

Quality Assurance shall be in accordance with Vendor Quality Specification (Doc. No. DHF-00-A-P-0005).

T&I CONTRACTOR shall have as part of its usual business practice an established, routine, and documented quality management program. This program shall be used to provide verifiable evidence that materials, design, fabrication, examination, inspection and testing conform to the Specifications and requirements established in the Purchase Order. This program shall ensure that all factors affecting reliability, safety and durability have been evaluated and properly tested and controlled.

- T&I CONTRACTOR shall have a quality management system and quality assurance manual covering all offshore construction and installation, pre-commissioning and testing activities. Controlled copies of the quality assurance manual shall be made available for EPC CONTRACTOR/ CLIENT's approval and for monitoring of all construction activities. The Quality Management System shall include a detailed Inspection and Test Plan together with appropriate procedures for each activity detailed therein. T&I CONTRACTOR's Quality Assurance Management System shall be in accordance with ISO 9001 Quality System Standards or equivalent and T&I CONTRACTOR shall maintain this Quality Assurance System throughout the contract period. When T&I CONTRACTOR sub-contracts the whole or parts of the work, then these requirements shall be applied in full to T&I CONTRACTOR's sub-contractor;
- T&I CONTRACTOR shall generate quality records from the inspection test activities listed in this specification and in accordance with the approved Inspection and Test Plan(s). The records shall be compiled and reviewed by T&I CONTRACTOR immediately following the completion of each inspection and test;
- T&I CONTRACTOR shall establish a procedure to document and provide traceability of all primary materials to their original mill certifications. The procedure shall identify methods for maintaining the identity of material from manufacturing stages through transport, receipt, storage, and final component fabrication. A system shall be employed for linking unique inspection records, weld numbers, and welder identification;
- T&I CONTRACTOR shall establish detailed procedures for control of welding quality. The procedures shall be submitted for review and approved by EPC CONTRACTOR/ CLIENT before starting fabrication and shall include as a minimum:
 - Stinger and pipe conveyor configurations;
 - Welding and weld repair;

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- Storage, control, and identification of welding consumables;
- Welder qualification records;
- Inspection/NDE;
- Post-weld heat treatment, if required;
- Monitoring the progress and quality of welding; and
- Material and NDE traceability.

T&I CONTRACTOR is responsible for complying with all of the provisions of this specification. CLIENT's Representative may make any investigation necessary to satisfy himself of compliance by the T&I CONTRACTOR and may reject any material that does not comply with any specific requirements. This does not relieve T&I CONTRACTOR from the obligation to carry out additional tests at the discretion of CLIENT's Representative (and at T&I CONTRACTOR's cost) in case serious doubt has arisen about certain quality aspects of the materials.

10. MATERIALS

The steel used for pipelines, flanges and fittings shall meet the requirements of project specifications referenced in Section 5.2 of this Specification. API monogrammed steel shall be used wherever possible unless specific approval is given in writing granting a waiver.

In case of EPC CONTRACTOR/ CLIENT supplied line pipes, flanges and fittings, any specific pipe end details, dimensional tolerances and coated line pipe cut-back requirements by EPC CONTRACTOR/ CLIENT shall be agreed during the bidding stage.

11. EQUIPMENT

11.1 GENERAL

T&I CONTRACTOR shall provide welding equipment which is suitable for the work and is capable of producing welds of the desired quality. If, in the opinion of EPC CONTRACTOR/ CLIENT, the field experience with the equipment is not satisfactorily documented or if the equipment will be used under new conditions, a pre-qualification test will be required.

All welding equipment and tools shall be in good working condition and shall have valid calibration. Current certification/calibration shall be available for review by EPC CONTRACTOR/ CLIENT Representative before commencing work.

The welding equipment and the related tools are subject to inspection and verification by EPC CONTRACTOR/ CLIENT. Any welding equipment which, in the opinion of EPC CONTRACTOR/ CLIENT, is inadequate to satisfy the requirements shall be

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replaced by T&I CONTRACTOR at no additional cost to EPC CONTRACTOR/CLIENT.

11.2 WELDING EQUIPMENT

The welding equipment shall be suitable for the ambient or controlled conditions for welding at the site. T&I CONTRACTOR shall obtain documentation from the SUPPLIER, which sets environmental limits for automatic equipment and a maintenance procedure, including spares, appropriate to the environment. The welding operations shall be carried out within a sheltered environment.

Machines in production shall be in good working order with calibrated meters for the measurement of parameters. T&I CONTRACTOR shall provide spare equipment, parts, maintenance expertise and dedicated repair facilities to service automatic equipment.

Automatic equipment shall be identified by a unique number with traceability of equipment to welds.

11.3 END PREPARATION EQUIPMENT

Pipes with damaged ends or ends requiring re-preparation after cutting shall be machined by dedicated end preparation equipment. Restoration to within the tolerances required by the welding procedure shall be applied. Linepipes supplied with plain ends shall be bevelled accordingly as per approved WPS groove configuration.

Prior to production, T&I CONTRACTOR shall demonstrate that end preparations of the required accuracy can be produced by the site equipment and personnel. This shall include end preparation on the pipe body after cutting more than 200mm from the end.

Maximum magnetism residual at the pipe end shall be 25 Gauss. T&I CONTRACTOR shall have available on site at all the times a demagnetization system for use when the pipe end shows magnetism not suitable for welding.

11.4 ALIGNMENT EQUIPMENT

Pipe alignment equipment shall operate internally and shall be designed to provide alignments specified in the welding procedure and this Specification.

The alignment of pipe assembly benches and rolls shall be demonstrated to provide for the straightness of the joined pipe.

12. WELDING PROCESSES

Welding processes for pipeline welds, consumables, and the requirements for consumable storage and handling shall comply with the requirements of API Standard 1104.

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13. WELDING CONSUMABLES

13.1 SELECTION

All welding consumables shall be selected from a list submitted to EPC CONTRACTOR/ CLIENT for approval prior to selection being made.

Low Hydrogen consumables and processes shall be used. Low hydrogen welding consumables shall give a diffusible hydrogen content of maximum 5ml / 100g weld metal.

If vacuum packed low hydrogen SMAW welding consumables are not used, low hydrogen SMAW consumables shall be stored, baked, handled and re-baked in accordance with the SUPPLIER's recommendation. Re-baking more than once shall not be permitted.

Welding consumables shall be selected to ensure that the yield strength and ultimate tensile strength of the as-deposited weld metal either meets or exceeds the SMYS and SMTS of the parent pipe material.

13.2 CASTS AND BATCHES

As far as practical, the number of casts/batches for filler rods and electrodes shall be minimized. Where there is more than one cast/batch, one shall be exhausted before the next is started, and the pipe number at the change shall be recorded.

T&I CONTRACTOR shall provide SUPPLIER's Test Certificates for each production batch or lot of welding consumables used in production. All casts/batches of welding consumables shall be batch tested and accompanied by batch test certificates as required by API Standard 1104.

13.3 IDENTIFICATION

Consumables shall be identified at all times during storage, conditioning, and distribution and at the welding stations. Identification shall include supplier, grade and batch number.

13.4 HANDLING AND STORAGE

A procedure for receiving, storing, and issuing consumables shall be submitted to EPC CONTRACTOR/ CLIENT for approval prior to commencement of the work.

Electrodes shall be supplied in fully sealed packages and stored in a dry storage room. If the identification is destroyed by baking, handling, or other causes, the electrodes shall not be used.

Electrodes shall be stored in portable heated rod containers when on the "firing line" after removal from sealed containers and/or heated bulk cabinets.

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Low hydrogen electrodes shall not be stored in heated cabinets containing electrodes of other types, such as rutile or organic type electrodes.

Wire spools for automatic and semi-automatic processes shall be stored in cabinets with SUPPLIER's wrapping in place and remain clearly identifiable up to the time of usage. Unidentifiable wire shall not be used.

Flux shall be handled and stored in accordance with the flux SUPPLIER's recommendations.

Each batch of flux and wire shall be labelled with the information from the supply container.

Unidentifiable, damaged, wet, rusty or otherwise contaminated or deteriorated consumables shall not be used.

All shielding gas containers shall have clear identification labels, which include the gas type.

14. WELDING PROCEDURES

14.1 GENERAL

Welding procedure qualifications shall comply with API Standard 1104.

Qualification shall be conducted on production pipe material unless otherwise approved by EPC CONTRACTOR/ CLIENT.

T&I CONTRACTOR shall submit to EPC CONTRACTOR/ CLIENT for approval all proposed welding procedure specifications (WPS) and weld repair procedures. Each WPS shall contain all essential variables.

The qualification test piece shall meet the acceptance standards of API Standard 1104 Section 6 for visual and radiographic examination.

The qualification test piece shall meet the mechanical property requirements of API Standard 1104 with the following additions:

- Charpy tests shall be conducted according to ASTM A370 on the weld metal, fusion line, fusion line + 2mm and fusion line + 5mm;
- The minimum absorbed energy and test temperature in according to section 14.3.

14.2 WELDING PROCEDURE SPECIFICATION

14.2.1 General

Prior to the start of production welding, the Welding Procedure Specification (WPS), including Weld Repair Procedure Specification, shall be prepared by T&I

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CONTRACTOR and qualified by both mechanical testing and NDT in accordance with API Standard 1104 and Section 14.3.

The welding procedures shall include all the information as mentioned in API Standard 1104 including all preheat requirements. Pipe material may be grouped according to API Standard 1104 Section 5.4.2.2. Specified wall thicknesses and pipe diameters listed for Qualification of Welders, Section 6.2.2 of API Standard 1104, shall be considered essential variables for the welding procedures.

Procedures shall also be provided for the following:

- Pre-weld cleaning;
- Alignment;
- Purging;
- Interpass temperature measurement;
- Inter-run cleaning including details of process and equipment;
- Final weld surface preparation.

The WPS shall include all parameters necessary to control the process and shall include, but not be limited to, the following parameters:

- Tools to be used for pre-welding cleaning;
- Welding process including number of wires;
- Welding position and direction;
- Material specification;
- Pipe dimensions (diameter and wall thickness);
- Joint configuration (sketch), including tolerances;
- Alignment, including tolerances;
- Number of runs and sequence;
- Welding consumables; (SUPPLIER's trade name and classification);
- Shielding gas type and flow rate;
- Purging gas type and flow rate;
- Duration for purge gas application;

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- Electrical characteristics including target amperage and voltage range, mode of metal transfer, polarity, heat input, etc. For pulsed arc welding, the pulsing characteristics, including the frequency, amplitude, shape, base level, delay and crater fill, shall be specified;
- Direction and speed of welding (for SMAW, electrode run out length may be specified);
- Line-up clamp type;
- Number of passes before removal of line-up clamp;
- Time laps between root and hot pass;
- Welding equipment;
- Wire stick-out;
- Preheat temperature and maximum interpass temperature;
- Stress Relieving, as applicable;
- Number of welders;
- Type of pipelay;
- Welding technique (stringer or weave, weaving width).

Welding consumables shall deposit weld metal which is compatible in chemical analysis and, as a minimum, equal in the mechanical properties of the parent material.

For shielding gases, the requirements of API Standard 1104 Section 4.2.3 shall be applied.

14.2.2 Essential Variables

A qualified welding procedure is valid as long as the essential variables are within the acceptable limits and the production tests show acceptable results. Essential variables shall be as per Table 1 API Standard 1104 requirements and following additions:

Material	Any change in pipe or fitting or steel specification / grade.
Thickness	A change in nominal thickness plus or minus 25% of the nominal thickness used during qualification when Impact test is required (API 1104 Sec. 5.4.2.2 (c) Table 1)
Welding Process	A change of model of automatic equipment.

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Weld Shape and Size	A reduction in the size of the root run (root run throat reduced by more than 1.0 mm).
Groove Design	A major change in joint design (for example, from V groove to U groove) or any change outside the specified joint design tolerances on the approved and qualified WPS.
Position and Direction	A change of position and direction of welding.
Purge Gas	A reduction in the number of runs with purge gas applied.
Shielding Gas	A change in shielding gas composition and nominal flow rate.
Type of Line-up Clamp	Any change in line up clamp from that used for procedure qualification.
Removal of Line-up Clamp	Any change in the number of runs before the clamp is released. Removal of the line-up clamp at a stage earlier than the approval procedure.
Filler Metal	<p>(a) A change from one filler metal group to another.</p> <p>(b) A change from AWS classification to another.</p> <p>(c) A change in the minimum specified yield strength of the filler metal.</p> <p>(d) A change in the diameter of electrode or filler metal.</p> <p>(e) A change in Brand/Manufacture.</p>
Number of Passes	Change in single pass to multi-pass or vice versa.
Welding Equipment	Change in type and model for automatic or semiautomatic welding equipment.
Welding Technique	Change for stringer bead to weave bead.
Time Lapse	Any significant increase in time lapse between root pass and filler pass.
Interpass Temperature	An increase in interpass temperature above qualified maximum interpass temperature. The maximum interpass temperature shall be 300 °C.
Welding Heat Input	A change heat input, due to combined change in current, voltage and travel speed or run-out length, beyond \pm

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	10% from the qualification.
Preheat Temperature	Reduction of minimum preheat applied during qualification.
Travel Speed	A change of more than 10% from the specified travel speed, or electrode run-out length.
GTAW Wire	(a) The addition or deletion of a second wire. (b) A change from a hot to cold wire addition or vice versa.
Oscillation	Change from stringer pass technique to oscillating technique in the root pass.
Wire Feed Speed	In semi-automatic and automatic welding processes any change of more than $\pm 10\%$ in the wire feed speed shall constitute an essential variable.
Location of Angle of Arc	A change of more than $\pm 10\%$ of the specified angle of the arc to the pipe tangent.
Number of Welders	A change in the number of root pass or hot pass welders shall constitute an essential variable.

For mechanized and automatic welding of pipeline girth welds, table 20 of API Standard 1104 requirements and following additions additional essential variables shall apply:

- Any change of control software;
- Any change of preset parameters (parameters that cannot be adjusted by the welder);
- Any change in programmed parameters and their variation, except that necessary variation in oscillation width for welding of thinner/heavier wall than used during qualification shall be allowed for mechanised GMAW and GTAW;
- Any change in limits for parameters that can be adjusted by the welder (“hotkey limits”);
- Any change in bevel angle by more than ± 1 degree, or a variation in root gap/root face by more than ± 25 percent;
- Any change in the batch or heat of filler wire used to qualify the procedure (wire with same brand and classification may be considered based on composition for use without retesting subject to CLIENT approval);

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- Any increase or decrease in heat input for any pass from the range qualified by more than $\pm 10\%$;
- Any change in shielding gas flow that exceeds $\pm 25\%$ required requalification;
- API Standard 1104 Section 12 shall apply for mechanized welding with filler metal additions;
- Torch oscillation, including torch oscillation speed and dwell time at the end of the oscillation shall be specified for each pass;
- Three consecutive complete test joints shall be made. Each test joint shall be subject to and must pass visual examination and non-destructive examination. One shall be selected for mechanical tests.

A change from a lower to a higher strength grade is permissible but not vice versa.

When pulsed-arc welding is applied the manufacture and model of the welding power supply and torch travel mechanism are essential variables.

For pulse arc welding, the wave form, pulse frequency, amplitude, peak and background voltage and current shall be essential variables.

14.2.3 Heat Input

Any combined change in current, voltage and travel speed or run-out length from the values in the accepted WPS, which causes an increase or decrease of more than 10% in the heat input, where heat input is defined as:

$$\text{Heat Input (KJ/mm)} = [\text{Current (A)} \times \text{Voltage (V)}] / [\text{Travel Speed (mm/s)} \times 1000]$$

The qualified heat input shall be the mean measured heat input for four zones in the weld:

- Root and hot pass;
- Fill pass;
- Cap pass.

WPS employed for fabrication shall be submitted with supporting PQRs to EPC CONTRACTOR/ CLIENT for review and approval prior to the start of any production welding.

Weld repair procedures shall also be prepared and approved in the same manner as production welding procedures.

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If T&I CONTRACTOR has existing Welding Procedure Qualifications (WPQ) and Procedure Qualification Records (PQR), such WPQ and PQR may be submitted for EPC CONTRACTOR/ CLIENT's review and approval.

EPC CONTRACTOR/ CLIENT shall be notified and have the right to witness all of the following:

- WPQs;
- Production Welding, Testing and Inspection;
- Welder Qualification Testing;
- Laboratory Testing;
- Test Data.

14.3 WELDING PROCEDURE QUALIFICATION

14.3.1 General

Following the preliminary acceptance of each welding procedure specification, qualification tests shall be carried out to demonstrate that sound welds, with the required mechanical properties, can be made using these welding procedures. EPC CONTRACTOR/ CLIENT shall be invited to witness all the welding procedure qualification testing (WPQT) and test results. Additionally, T&I CONTRACTOR shall engage an independent Third Party Inspector to witness and to certify the PQR and mechanical tests.

The quality of the welds shall be determined by both non-destructive and destructive testing as specified in this document. EPC CONTRACTOR/ CLIENT shall witness the welding procedure qualification testing (WPQT).

Qualification of welding procedures shall be in accordance with API Standard 1104 and this Specification.

Separate welding procedure specifications and respective qualifications are required for:

- Pipe to pipe welding;
- Pipe to hub/flange welding;
- Repair welding (except in the case of weld cut-out and re-weld);
- Pipe to barred tee welding;
- Pipe to WYE welding;

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- Pipe to Reducer welding.

For pipeline welding procedure qualification, two pipe lengths, including at least one full-length, shall be welded together using production line up and clamping equipment. A further two pipe lengths shall also be welded if necessary to obtain the required number of specimens for testing. Test welding shall prove the limitations of internal bore misalignment within the limits specified in Section 16.3.6.

The procedures shall be qualified on pipe material of the same cast as the production material.

Welding procedure qualification for welding pipe to hubs or flanges shall be on project hub or flange material, test rings. The same shall apply for welding procedure qualification for barred tees, WYE and Reducer. Spool WPQT on pipe nipples shall be performed on the same pipe size and same pipe production material. The length for WPQT may be of reduced length (0.5m minimum).

The WPS shall be qualified by welding one or more test joints as required by this Specification. Weld Repair Procedure Specification shall be qualified and shall include:

- Full penetration repair;
- Partial penetration repair;
- Cap repair.

Repairs shall be permitted for a maximum of two attempts at the same areas.

For manual welding, the WPQ test joints shall be subjected to NDT and subsequent mechanical testing as per Section 14.3.2 and Section 17.

For semi-automatic, a minimum of three test joints shall be made, and subjected to the same NDT tests as for manual welding, or using AUT. One of these test joints shall be subjected to mechanical testing.

For procedure qualification, the time lapse between welding and NDT shall be 24 hours minimum.

The welded test joints shall be subjected to the same cooling conditions envisaged for production welding. If delayed cooling of the welded joint is to be adopted, the details shall be specified in the WPS. If the production weld is to be cooled rapidly to allow immediate AUT, then this shall be simulated during the WPQT Project. Assisted cooling shall not commence until the weld has cooled naturally without interference to below 300°C.

Measurement of welding parameters during the welding procedure qualification tests shall be performed. All measuring instruments employed during qualification testing

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shall be calibrated. Calibration records, including expiry dates, shall be made available for inspection by EPC CONTRACTOR/ CLIENT.

All costs of qualifying welding procedures, and the engagement of Third Party Inspector for witnessing and certifying, shall be at T&I CONTRACTOR's expense. T&I CONTRACTOR shall organize all test equipment required for destructive testing of welds and notify EPC CONTRACTOR/ CLIENT of date and location of welding procedure qualification test at least 3 weeks prior to start of the test.

14.3.2 Testing Requirements for Welding Procedure Qualification

All qualification testing shall be in accordance with API Standard 1104 and this Specification.

14.3.2.1 Non-Destructive Testing of Test Welds

On completion of welding, all procedure qualification test pieces shall be left at ambient temperature for at least 48 hours and shall then be subjected to NDT in accordance with this Specification. This shall be carried out prior to sectioning for mechanical testing.

NDT of welding procedure qualification tests shall be performed using the same radiography procedure to be used in production.

The NDT shall consist of:

- 100% visual examination of the entire weld;
- 100% Magnetic Particle Testing;
- 100% Radiographic testing and 100% ultrasonic testing.

Acceptance criteria for the NDT shall be as stated in this Specification. If a test weld is found to be unsatisfactory following NDT, it shall be rejected and not be submitted for destructive and/or mechanical testing.

14.3.2.2 Destructive Testing of Test Welds

The weld procedure qualification test coupon(s) shall be tested in accordance with API Standard 1104 and the following:

- The number of test specimens shall be as per API Standard 1104, Section 5.6, Table 3;
- The location of test specimens shall be as per API Standard 1104, Figure 3;
- All test facilities and test certificates shall be endorsed or approved by a EPC CONTRACTOR/ CLIENT approved agency.

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Tensile Testing

Transverse tensile test of the weld shall prove that the ultimate tensile strength of the joint is at least equal to the specified minimum ultimate tensile strength of the linepipe material. Tensile strength of weld, including fusion zone, shall be greater or equal to actual tensile strength of parent metal. The yield strength (Rt0.5), ultimate tensile strength and the elongation of the all-weld tensile shall not be less than those specified for linepipe material as per “Specification for Linepipes” (Doc. No. WHP-DHN-L-S-0001).

Macroscopic Examination

Specimens shall be prepared for macroscopic examination by grinding to a 600 grit paper finish. The prepared surfaces shall be etched using a suitable etchant to reveal the grain structure.

The sections of the weld taken for macroscopic examinations shall be used for hardness testing.

The macro-specimens shall be examined at a magnification of x25 and shall exhibit good penetration and absence of cracks or other features which would be cause for rejection as specified in this Specification. Each specimen shall exhibit a smooth and regular profile, and the reinforcement shall blend smoothly with the parent metal.

The macro-specimen shall be photographed and included in the test report.

Hardness Testing

The hardness shall be measured in accordance with ASTM E92 using a Vickers testing machine with a 10kg maximum load. For pipe butt welds, hardness traverses shall be carried out on lines 1.5mm from the carbon steel inner and outer pipe surfaces on the weld cross-sections, and also a line through the mid wall if the pipe thickness is greater than 16mm.

Lines of indentations shall give at least three values in each of the weld metal, the HAZ each side of the weld, and the base metal. One HAZ impression each side of the weld, shall be within 0.5mm of the weld junction.

The maximum hardness levels attained in each of the three zones of the carbon steel, i.e. parent metal, HAZ and weld metal zone shall not exceed 250HV₁₀.

Charpy V-Notch Testing

Charpy tests shall be conducted according to ASTM A370 on the weld metal, fusion line, fusion line + 2mm and fusion line + 5mm. The specimens shall be taken from the mid-thickness with the notch in a radial orientation

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For carbon steel, the test temperature shall be 18°F (10°C) lower than the minimum design temperature, or 0°F (-18°C), whichever is less. The minimum design temperature shall consider the potential effects of blowdown, gas filling or upset conditions.

The minimum absorbed energy shall be 50 J (37 ft-lbs) average and 41 J (30 ft-lbs) minimum.

Where parent material toughness is not required, Charpy tests shall be conducted at –18°C (0°F). Based metal and HAZ results shall be conducted for information only. Minimum weld metal values shall be 20 ft-lb (27 J) average and 15 ft-lb (20 J) individual.

Crack-Tip-Opening Displacement (CTOD) Testing

Crack-Tip-Opening Displacement (CTOD) testing shall be performed for the weld metal at the specified minimum design temperature (0°C) for wall thicknesses greater than 13mm only.

CTOD testing shall be carried out in accordance with API Standard 1104. Minimum CTOD value shall be 0.15mm.

CTOD test procedure of girth weld shall be carried out only if ECA is executed.

Bend Test

The root and face–bend testing shall be carried out according to API Standard 1104 Section 5.6.4.

The root and face–bend test shall be considered acceptable if no crack or other imperfection exceeding 1/8 in (3mm) or one-half the nominal wall thickness, whichever is smaller, in any direction is present in the weld or between the weld and the fusion zone after bending. Cracks that originate on the outer radius of the bend along the edges of the specimen during testing and that are less than 1/4 in (6mm), measured in any direction and shall not be considered unless obvious imperfections are observed. Each specimen subjected to the bend test shall meet these requirements.

The side-bend testing specimen and method shall be performed according to API Standard 1104 Section 5.6.5. Side-bend test specimen shall meet the root and face–bend test requirements specified above.

14.3.3 Welding Procedure Qualification Test (WPQT) Acceptance

EPC CONTRACTOR/ CLIENT reserves the right to accept or reject, at any time, in whole or in part, any or all welding procedures which deviate from the requirements of this Specification. In the event such circumstances occur, regardless of the status of the work, T&I CONTRACTOR shall not continue with welding until the unacceptable procedures are remedied to CLIENT's satisfaction.

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Acceptance or approval by EPC CONTRACTOR/ CLIENT shall not in any manner, or to any degree, alter the T&I CONTRACTOR's responsibility for producing sound and acceptable welds.

14.3.4 Repair Welding Qualification

Weld repair shall be carried out as per the qualified Weld Repair Procedure. In addition to the information required by Section 10 of API Standard 1104, repair welding procedures shall also include information on method of defect removal, preparation of weld area, method of ascertaining the defect removal and sequence of re-welding.

Partial or full thickness multipass repair welds may be made with an original qualified mainline welding procedure provided the welding process is low hydrogen and a method statement detailing the intended repair techniques is prepared and approved by EPC CONTRACTOR/ CLIENT. Repairs with such procedures shall be made with preheat no less than 100°F higher than that used to qualify the original referenced mainline procedure.

Single pass cap repairs shall be qualified by making a single bead on base metal using the lowest preheat and heat input intended for production. A hardness survey shall be conducted in accordance with the requirements of Hardness Test sub-section except that hardness measurement shall be made all along the fusion line at a distance of 0.20 – 0.50 mm from the fusion line with a maximum spacing of 1 mm.

Weld Repair Procedure Specification shall be qualified as per the requirements of Section 14 of this Specification. A weld repair qualification test shall be performed on each WPS that will have weld repairs performed on it during production.

The welding repair qualifications tests for each WPS shall consist of the following:

- Through-thickness repair;
- Partial-thickness repair;
- External repair of undercut with one stringer pass.

T&I CONTRACTOR shall submit the Weld Repair Procedure Specification for EPC CONTRACTOR/ CLIENT's approval prior to commencement of the repair. EPC CONTRACTOR/ CLIENT reserves the right to accept or reject T&I CONTRACTOR's proposal for repair and require the joint cut-out and re-welded.

All the costs for repair and re-welding, including the cost of qualification of Weld Repair Procedure Specification shall be at T&I CONTRACTOR's sole expense.

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15. WELDER QUALIFICATION

15.1 GENERAL

Welder and welding operator qualifications and testing shall meet the requirements of API Standard 1104, or ASME B31.8/ ASME B31.4 (as applicable for the project) and the supplemental requirements of EPC CONTRACTOR/ CLIENT specification.

Before starting production welding, all welders shall be qualified in accordance with EPC CONTRACTOR/ CLIENT approved welding procedures. Horizontal pipe shall be used to quality 5G position. No welder shall do any phase of welding on the pipeline for which he has not been qualified and previously approved by the INSPECTOR. All cost of qualifying the welders shall be borne by T&I CONTRACTOR.

All welders' qualification tests shall include mechanical testing after the test coupon are accepted by radiography or AUT.

Welder qualification activities shall commence no later than three (3) weeks prior to the start of production welding. Regardless of this mandated time requirement, based on complexity location and availability, location and availability of welders, T&I CONTRACTOR shall plan appropriately to allow adequate time (which may exceed 3 weeks) to replace any and all welders who fail to pass the qualification testing such that production schedule is not affected due to lack of fully qualified welders.

T&I CONTRACTOR shall immediately remove from the project any welder who, in the opinion of EPC CONTRACTOR/ CLIENT, is not careful, skilled, or who is incompetent or negligent in the proper performance of his duties.

Welder qualifications for a particular process shall be considered expired if the welder has not employed the process in any six (6) month period. Documented evidence shall exist to support this requirement.

15.2 WELDER TEST

EPC CONTRACTOR/ CLIENT's representative shall witness all welder qualification tests given to all welders employed by T&I CONTRACTOR for any part of the work. All welder qualification tests shall be in accordance with API Standard 1104 and requirements of this Specification, and shall be at T&I CONTRACTOR's expense. T&I CONTRACTOR shall furnish all test equipment required for destructive testing.

All new qualification tests shall be carried out with equipment similar to that used during production welding, and if practicable where production welding is to take place, i.e. workshop, yard, or vessel.

T&I CONTRACTOR shall prepare all pipe specimens, and furnish all welding materials, equipment and welders. T&I CONTRACTOR shall test all welds by destructive and non-destructive test methods in accordance with API Standard 1104.

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Test welds may be carried out by two welders per joint in accordance with the qualified weld procedure if the pipe size is sufficiently large to permit all required test coupons to be removed. In that case welders shall be qualified based on test results from their respective weld sections.

Manual and semi-automatic welders shall be separately qualified for each welding position encountered on the job.

- **Prior Qualifications:**

Should the T&I CONTRACTOR employ welders who have qualified to any CLIENT's approved existing welding procedure within the previous six (6) months, T&I CONTRACTOR may submit such welder qualifications for EPC CONTRACTOR/ CLIENT T's review. EPC CONTRACTOR/ CLIENT, at its sole discretion, may accept some or all such existing welder qualifications in place of requiring new welder qualification.

- **Documentation:**

Welder qualification reports for each procedure to which a welder qualifies shall include all data shown in the API Standard 1104, plus procedure identification. These reports shall be submitted to EPC CONTRACTOR/ CLIENT for approval.

EPC CONTRACTOR/ CLIENT reserves the right to require additional test welds at any time before or during T&I CONTRACTOR's performance of the Work for any reason.

EPC CONTRACTOR/ CLIENT also reserves the right to cut-out production welds for testing in accordance with API Standard 1104. In the event any such test weld cut from the line does not prove satisfactory to EPC CONTRACTOR/ CLIENT, when properly tested, it shall be replaced by T&I CONTRACTOR at T&I CONTRACTOR's expense. In the event any welder has more than three cut-outs, that welder shall be removed from the production line for the duration of the job.

15.3 RE-QUALIFICATION OF WELDERS AND WELDING OPERATORS

Requalification of welders or operators shall be required if any change is made to the welding procedure which necessitates requalification of the welding procedure. Requalification of welders or operators shall be required where established tolerances on weld procedures are exceeded.

EPC CONTRACTOR/ CLIENT reserves the right to require the re-qualification of welders or welding operators if their repair rates during production welding are considered by EPC CONTRACTOR/ CLIENT to be excessive, or if there is any reason to question the performance of welding.

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15.4 IDENTIFICATION OF WELDERS

After EPC CONTRACTOR/ CLIENT has determined that the welder has passed all welder qualification requirements, T&I CONTRACTOR shall issue an identification number to that welder and each weld made by that welder shall be so identified with an ink pipe marker on the top quarter of the pipe. Die stamping shall not be allowed.

Any weld worked on by more than one welder shall be identified by the number of each and every welder participating in the weld. T&I CONTRACTOR shall keep EPC CONTRACTOR/ CLIENT informed with an up-to-date list of the identification numbers and welders names.

16. PRODUCTION WELDING

16.1 GENERAL

All works shall conform to API Standard 1104, ASME B31.4, or ASME B31.8 as applicable and the additional requirements of this Specification. Any discrepancies in the referenced codes and specifications shall be reported to EPC CONTRACTOR/ CLIENT representative for resolution.

WPS that are approved for fabrication shall be posted at each applicable work location and shall be readily available to each welder and welding operator.

T&I CONTRACTOR shall submit descriptions of all welding equipment, types of machinery, welding materials to be used, tools, and all other required items to EPC CONTRACTOR/ CLIENT for approval. This equipment shall consist of, but not be limited to: D.C. welding machines, welding generators, equipment and machinery for cutting, beveling, preheating and post-weld heat treating (PWHT), internal and external lineup clamps, welding consumables, welders' tools, tents, and insulation blankets for weather protection.

All welding machines, line up clamps, beveling machines, cutting torches, plus other equipment, tools and supplies used in connection with the welding work shall be kept in good mechanical and electrical condition so as to produce sound welds. If Automatic Ultrasonic Testing (AUT) is used as the NDT method of inspection, the minimum distance shall be adjusted so that the welds do not interfere with the AUT scanning

T&I CONTRACTOR shall provide sufficient welding equipment technicians for major repair and maintenance of automatic and manual welding equipment on each shift.

T&I CONTRACTOR shall provide sufficient spare parts and equipment for automatic welding to maintain a high level of productivity without significant down time.

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Welding shall not be performed when the weld quality may be impaired by the prevailing weather conditions such as cold, rain, storm, salt water spray, or high winds.

16.2 WELDING SUPERVISION

T&I CONTRACTOR shall provide continuous and competent welding supervision of all welding, including the appointment of a designated Welding Engineer and welding supervisor(s). Welding supervisors shall be qualified by training and experienced on the automatic equipment, and documented for the approval of the EPC CONTRACTOR/ CLIENT.

Production welds shall be monitored either manually or electronically to ensure that the heat input requirements qualified in accordance with Section 14.2.3 of this Specification.

The method of monitoring, personnel responsible and documentation required shall be included in the ITP for the project.

If manual monitoring is used, the amperage, voltage and travel speed shall be documented for each weld layer.

If electronic devices are used, T&I CONTRACTOR shall provide continuous monitoring and logging of at least the RMS voltage and amperage for each weld pass.

The electronic device shall calculate and provide a hardcopy of the average heat input of each welding pass.

16.3 PREPARATION OF PIPE

16.3.1 Swabbing

Each joint of pipe shall be internally swabbed along its full length, immediately prior to alignment with the pipeline.

Swabbing shall remove all dirt, mill scale and other foreign material inside the pipe.

The swab shall incorporate a steel disc, minimum 6.25mm thick, with a diameter 3.2 ± 0.2 mm less than nominal internal pipe diameter.

In the event that the steel disc will not pass through the pipe joint with the plane of the disc at right angles to the pipe wall, that pipe joint shall not be installed in the pipeline. Each rejected pipe joint shall be clearly marked as “REJECTED PIPE JOINT” and removed from the job site.

16.3.2 Marking

Before materials are cut, permanent identification (heat/pipe numbers) shall be transferred.

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Each weld shall be marked with the identification symbol of the welder or welding operator next to the weld area or records shall be maintained to identify the work of each welder, i.e., weld numbers, shift, passes, left or right side of pipe, etc. Failure to use the symbol or maintain adequate records shall be cause for rejection of the work and removal of the weld.

For all welds, weld identification numbers shall be painted on the pipe coating using contrasting colors. A reference between weld numbers and pipe numbers shall be maintained. Each weld number shall be located from 1:00 to 5:00 and 7:00 to 11:00 next to the weld. The width of each letter or number shall not be less than $\frac{3}{4}$ inch (19 mm). Weld identification must be legible using sequential numbers and/or combination of English block letters and numbers.

16.3.3 End Preparation

All linepipe joints will be furnished with bevelled ends based on EPC CONTRACTOR Specification “Specification for Linepipes” (Doc. No. WHP-DHN-L-S-0001).

The sections of the pipe that have been previously cut-off shall be re-beveled by the T&I CONTRACTOR after checking for end laminations by ultrasonic testing and magnetic particle inspection.

The external surface of each joint of pipe shall be buffed from the coating edge to the beveled edge 50mm minimum to remove all rust, scale, dirt, or other foreign materials prior to placing in alignment for welding into the line. Grinding shall not be allowed for this purpose.

All paint, rust, scale, dirt, oil, moisture, or other foreign material that may adversely affect the quality of the welds shall be removed from the bevelled end prior to welding. Said removal shall be accomplished by buffer, wire brush or other method acceptable to EPC CONTRACTOR/ CLIENT. Bevels shall be inspected by the T&I CONTRACTOR to ensure that they are undamaged and in accordance with standard API 5L bevel. Bevelled ends that have been damaged during handling shall be repaired or re-bevelled by the T&I CONTRACTOR.

16.3.4 Cut-Out and Cut-Back

Pipes may be cut-out or cut back and re-beveled provided the requirements of Section 16.3.3 are met.

After cutting of pipe, material shall be removed by machining into unaffected base material. If the pipe ends have been cut back more than 25mm, they shall be subjected to UT lamination check according to “Specification for Linepipes” (Doc. No. WHP-DHN-L-S-0001).

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The new bevel shall be examined by Dye Penetrant Inspection / Magnetic Particle Inspection. The dye penetrant inspection / magnetic particle inspection procedures shall comply with the requirements of ASME BPVC Section V, Article 6 & 7 respectively. Acceptance criteria are given in the linepipe specification.

16.3.5 Defective or Damage Pipe

Should laminations or split ends be discovered in the pipe during the process of welding, the full joint containing such defect shall be removed from the line and shall not be used in the work.

If the ends of the pipe are damaged to the extent that satisfactory welding cannot be obtained, the pipe shall be cut and bevelled to the API 5L bevel with a EPC CONTRACTOR/ CLIENT's approved bevelling machine.

The cost of cutting, double handling and/or bevelling any joint shall be borne by T&I CONTRACTOR.

16.3.6 Butt Weld Alignment

Butt weld alignment shall comply with the tolerances of the qualified PQR for all locations around the ID and shall meet the requirements of API Standard 1104, the qualified weld procedure dimensional limitations, and the conditions of this section.

Internal grinding or machining may be conducted to improve root alignment if misalignment is equal to or less than 1/8 inch (3.2 mm). However, 1 in 4 tapers shall be minimum and the minimum wall thickness shall be maintained.

Internal clamps capable of maintaining the required alignment tolerances shall be used wherever possible. Internal line-up clamps shall hold the pipes in position maintaining alignment for the entire root pass deposition.

Use of Lineup Clamp for Butt Welds:

- The alignment of the abutting ends shall be made as to minimize the radial offset. Any misalignment shall be reduced to a minimum by rotation of the pipes, to obtain the best fit;
- All pipes shall be aligned with suitable line-up clamps to ensure accurate alignment and spacing. Mitre joints shall not be allowed. Pneumatic internal line-up clamps shall be used for mainline welding of pipe over 150mm in diameter. For tie-in welds, external line-up clamps may be used for all pipe sizes;
- Where external clamps are used, all welding shall be performed by an uphill technique only. Details of the internal (and/or) external alignment clamp proposed for the production welds shall be submitted for EPC CONTRACTOR/ CLIENT's approval prior to the commencement of production welding. However, the line-up clamp design shall be such as to minimize damage to external coating;

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- EPC CONTRACTOR/ CLIENT may consider internal clamp removal or "Pulling on the Bead" provided the root pass is made by an automatic welding process and the thickness of the root deposit is substantially greater than typical manual root passes. First passes on the ID of the pipe are not considered by themselves to be completed root passes;
- Internal alignment clamp may be removed to allow repair of internal weld misfires. At least 50% of the initial external weld pass must be completed before such removal of internal alignment clamp;
- Force or heating shall not be used to correct the misalignment other than nominal forces associated with the use of conventional clamps.

Movement of Pipe during Welding:

- The pipe shall not be moved until the root bead is completed.
- When cellulose coated electrodes are used to weld the root pass, the pipe may be moved when the following condition applies:
 - Pipe supported to the satisfaction of EPC CONTRACTOR/ CLIENT or;
 - Root bead cracking did not occur during production welding.
- If the above conditions are not achieved, then the hot pass shall also be completed prior to pipe movement.

16.3.7 Change in Wall Thickness

Where the internal diameters of the pipe being joined differ, but the grades of pipe are the same or the thicker walled pipe is of a higher grade, the welding shall be done in accordance with special provisions of API Standard 1104.

In general, the inside of the thicker walled pipe or fitting shall be smoothly tapered to the internal diameter of the thinner walled pipe or fitting so that the pieces accurately mate together. T&I CONTRACTOR shall furnish the internal tapering machine, subject to EPC CONTRACTOR/ CLIENT's approval, and perform all work necessary to internally taper the ends.

16.4 PREHEATING

Preheating shall be accomplished by a method acceptable to EPC CONTRACTOR/ CLIENT and shall cover a band at least 75mm wide on each side of the weld.

The preheat temperature shall be the same as determined at weld procedure qualifying stage, taking into account chemical composition as given in the pipe mill certificates. The preheat temperature required by the qualified WPS shall be maintained during entire welding and shall be checked by the use of temperature indicating crayons or digital thermocouple i.e. interpass temperature control. However, even if preheat is not

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specified in the WPS, it is recommended as a normal practice for the purpose of driving off moisture. Preheating temperature shall be such that there is no damage to the pipeline protective coating.

The following conditions shall require preheat:

- When welding pipe to fittings, or fitting to fitting joints, including valves.
- On all repair welds except for recapping. Repair welds shall be preheated in the area of repair extending a minimum of 75mm beyond the ends of the repair cavity.
- Preheating requirements for repair welds will be as per EPC CONTRACTOR/ CLIENT's approved welding procedure qualification.
- When, for any reason, preheating is necessary for a specific welding procedure and material combinations to alleviate existing conditions that would limit the welding technique or adversely affect the quality of the weld.
- When, for any reason, pipe is wet, or atmospheric humidity is high.

16.5 WELDING

16.5.1 General

Consecutive weld runs shall not be started at the same point.

The completed weld shall have a uniform cross-section around the pipe circumference. At no point shall the weld preparation be incompletely filled.

16.5.2 Welding Process

Welding shall be carried out using manual, semi-automatic or automatic process or combination of the processes that has been fully qualified according to the requirements of this Specification. Only the following processes are acceptable:

- Shielded Metal Arc Welding (SMAW);
- Mechanized or Semi-Automatic Gas Metal Arc Welding (GMAW);
- Gas Tungsten Arc Welding (GTAW);
- Gas Shielded Flux Cored Arc Welding Process FCAW-GS.

The use of welding processes other than those listed shall require prior review and approval from EPC CONTRACTOR/ CLIENT.

16.5.3 Working Clearance

When the pipes are welded, sufficient working clearance shall be maintained for welding and inspection.

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16.5.4 Weld Starts and Stops

Weld starts and stops shall be staggered such that adjacent or subsequent weld passes do not coincide with one-another.

All starts and stops in the root pass shall be ground to a smooth taper prior to depositing the next weld bead.

The hot pass shall be deposited no later than the time delay between the root and hot pass qualified on the WPS.

All pressure containing welds shall be made with a minimum of two passes with overlap of starts and stops.

16.6 EARTHING

All earthing connections shall be securely attached to avoid stray arcing. Welding of the earth connection to the pipe being welded shall not be permitted.

Precautions shall be taken during welding to ensure that no electrical arc burns occur between the welding machine ground lead and the pipe and fittings.

Any arc burns shall be removed by grinding and subsequently checked by non destructive testing in accordance with Section 17.

All arc burns on the pipe, on the finished weld, and outside the weld bevel shall be removed by cutting out the cylindrical section of the pipe that contains the arc burn.

At the discretion of EPC CONTRACTOR/ CLIENT, arc burns may be eliminated in accordance with a T&I CONTRACTOR developed Arc Burn Inspection/Removal procedure. This procedure shall be submitted to EPC CONTRACTOR/ CLIENT for review and approval prior to use.

The Arc Burn Inspection/Removal procedure shall include the following:

- Method of determining the wall thickness of the pipe in the area of the arc burn;
- Method of grinding/filing the arc burn from the body of the pipe;
- Method of inspecting the area to ensure the arc burn HAZ has been removed (i.e. ammonium persulfate or nital solution etch);
- NDT method of inspection of the area for evidence of cracks;
- Method of confirming the remaining wall thickness after grinding/filing.

In the event that the remaining wall thickness is less than the project specific minimum wall thickness, the affected pipe shall be cut out as a cylinder.

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16.7 SPACING OF WELDS

The spacing of welds shall meet the requirements of the following based on the type of weld and attachment:

- The maximum possible distance shall separate circumferential butt welds. However, between piping fittings and tie-ins, etc., short pipe lengths may be required. In this situation, butt welds shall not be within 3 inches (75 mm) or one nominal pipe diameter of adjacent butt welds, whichever is greater. For pipe less than 3 inch nominal size, butt welds should be separated from adjacent welds by the greater of four (4) times the wall thickness, or one pipe diameter. Circumferential butt welds closer than the above limits shall not be permitted without specific EPC CONTRACTOR/ CLIENT's approval;
- Attachment welds that are not pressure containing, such as pipe support welds, are generally not allowed on the surface of the pipeline. If such welds are part of the approved design, then each shall be a minimum of 2 inches (50 mm) from any other pressure containing welds (measured toe-to-toe).

16.8 WELD FINISHING

Upon completion of each welding pass, the weld shall be visually inspected and cleaned as required before starting the next pass.

Weld cleaning may be accomplished using power wire brush or grinder, or with hand tools. Power tools shall be used if specified in the qualified WPSs.

After the completion of the joint, the weld and the adjacent area shall be cleaned of spatter.

Welds shall be left as welded and shall not be treated by any mechanical means to change their appearance. Welds shall not be peened.

16.9 SURFACE FINISHING

When welding is completed, all surfaces adjacent to the welds shall be cleaned to allow proper radiographic or ultrasonic inspection, and to remove all detrimental burrs and other marks. Cleaning procedures shall be indicated on the welding procedures or drawings. Any damage shall be rectified prior to NDT.

16.10 IDENTIFICATION OF WELD

Unless otherwise specified by EPC CONTRACTOR/ CLIENT, all welds shall be numbered in the future flow direction. The numbering system shall be established and approved by EPC CONTRACTOR/ CLIENT before the commencement of installation.

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16.11 MINIMUM REQUIREMENT OF WELD RECORD

Each pipe shall have a unique identifying number which shall be, or shall cross-reference, the mill pipe number.

The weld identification number and welder identification number(s) shall be clearly marked adjacent to the weld prior to commencement of welding. Subsequent welders/operators shall write their identification codes below the first code in the sequence in which they work. The identification marks shall not be removed until after the welds have been both visually and non-destructively inspected and accepted.

Each weld shall have its number cross-referenced to adjacent pipe numbers, welder identification numbers, welding machine number, welding station, consumable batch/cast number and date of welding.

The weld numbers shall also be cross-referenced to visual inspection report numbers, radiographic identification numbers and any other NDT test reports produced.

Repair welds shall include the Suffix “R” after the weld number.

T&I CONTRACTOR shall maintain a register of qualified welders, and all welder qualification records relevant to the project. EPC CONTRACTOR 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 produced. This shall be reported to the EPC CONTRACTOR/CLIENT on a daily basis.

EPC CONTRACTOR/ CLIENT shall have the right to remove any welder from the job if his performance is considered to be of an unacceptable standard.

A shift record shall be kept and shall contain details of rejected and repaired welds. When welds are rejected the record shall state the pipe number, weld number, weld procedure number, station number, welder's name, defect classification and its location in the weld.

A daily report on repair rates and defect types shall be presented to the EPC CONTRACTOR/ CLIENT.

17. INSPECTION AND TESTING OF PRODUCTION WELDS

17.1 GENERAL

T&I CONTRACTOR shall submit and demonstrate the required examination procedures for EPC CONTRACTOR/ CLIENT's approval before any welding.

All girth welds shall be 100% visually inspected and subject to 100% NDE using either radiography or automated ultrasonic testing (AUT) with the following provision:

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- Radiographic technique shall be proven and demonstrated as compatible with joint configuration and weld process;
- AUT technique shall be proven and demonstrated as compatible with joint configuration and weld process.

General Non-Destructive Testing (NDT) requirements are as follows:

- T&I CONTRACTOR shall submit Non-Destructive Testing procedures, in accordance with API Standard 1104, Section 11, including equipment and NDT personnel resume, to EPC CONTRACTOR/ CLIENT for approval;
- All circumferential welds shall be examined either by radiographic or ultrasonic examination over their entire length using the approved procedure. Any weld, which exhibits flaws exceeding the limits specified in this Specification, shall not be accepted;
- NDT methods and techniques shall be suitable for the detection of cracks and surface breaking, planar, root defects (e.g. incomplete fusion or penetration);
- All NDT equipment shall be maintained in good working order and the facilities and equipment shall be to the satisfaction of the EPC CONTRACTOR/ CLIENT;
- Weld inspection and test results shall be available to the EPC CONTRACTOR/ CLIENT immediately following the completion of the radiographic inspection, film development and interpretation;
- Analysis of defect rate shall be available to the EPC CONTRACTOR/ CLIENT with break down according to period, defect type and location;
- T&I CONTRACTOR's NDT sub-contractors shall be certified to ISO 9001 by a recognised certifying body;
- **Non-Destructive Testing personnel shall be qualified in the techniques being used, in accordance with ISO 9712, or approved equivalent. A level II inspector is required for interpretation of radiographs.**

The extent of inspection for other applications shall be as defined in contract documents, or ASME B31.8/ ASME B31.4 as appropriate. When less than 100% inspection is required, the welds shall be selected to ensure that the work product of each welder or welding operator doing the production welding is included.

EPC CONTRACTOR/ CLIENT/INSPECTOR shall have free access to all areas of T&I CONTRACTOR's facilities at all times while the project is in progress and shall have the right to inspect storage, fabrication, welding, testing and radiographs at any stage of production.

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EPC CONTRACTOR/ CLIENT's representative may be present during examinations/inspections. T&I CONTRACTOR shall give sufficient notice before non-routine examination is scheduled to take place so that EPC CONTRACTOR/ CLIENT can arrange to have a representative present before any welding occurs.

17.2 VISUAL EXAMINATION

Weld inspection by the T&I CONTRACTOR shall be done by the dedicated and qualified welding inspectors. Inspection shall include in-process inspection on fit-up and inter-run quality and adherence to procedures. Results of all inspections shall be documented.

Visual inspection shall be carried out by EPC CONTRACTOR/ CLIENT, at EPC CONTRACTOR/ CLIENT discretion, at the following stages:

- End preparation;
- Root run;
- Completed weld.

Close visual inspection shall be carried out in all accessible surfaces of the finished welds with adequate lighting.

Acceptance criteria shall be as per API Standard 1104, which includes the following:

- No cracks are permitted. Cracks shall be cause for a complete cut-out;
- Maximum misalignment shall not exceed the tolerance set in the welding procedure specification;
- Maximum internal and external bead penetration shall not exceed 3mm. Where misalignment occurs, the height shall be the larger of the measurements either side of the bead;
- Inadequate root penetration, inadequate penetration due to high-low and incomplete root fusion shall not be permitted.

Inspection by EPC CONTRACTOR/ CLIENT shall not absolve the T&I CONTRACTOR from his responsibility to exercise quality control procedures to ensure that the requirements of this Specification are fully complied with.

17.3 RADIOGRAPHY

17.3.1 General

If radiography is used, welds shall be examined by means of X-rays unless pipe size is too small for commercially available X-ray equipment. Smaller diameters may be examined by either internal or external gamma ray (Iridium 192) equipment.

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Wire type Image Quality Indicators in accordance with ISO 1027 shall be used.

The film shall be Fine Grain (Agfa D7 or equivalent).

Intensifying screens shall be either lead foil or fluorometallic and shall be such that the required sensitivity can be obtained. Salt screens shall not be permitted.

The minimum film density over the weld area shall not be less than 2.0 and should not be greater than 4.0 for single film viewing. Radiographs with density up to 4.0 may be acceptable if adequate viewer capacity is readily available.

The procedures shall include the methods proposed for identifying each radiograph to the weld or part of a weld examined and the location of that weld in the pipeline.

Radiography of production welds shall not commence until the EPC CONTRACTOR/ CLIENT has given approval in writing and no change shall be made to any radiographic procedures without written approval.

No weld shall be moved from the radiographic station until the radiography of the weld has been accepted.

The limit on location and size of weld repairs beyond the final pipe tensioners shall be determined by calculation by T&I CONTRACTOR and shall be approved by EPC CONTRACTOR/ CLIENT.

No weld shall be field joint coated and/or moved off the site if rejected by the EPC CONTRACTOR/ CLIENT /INPSECTOR.

EPC CONTRACTOR/ CLIENT may call for the rejection of a weld on radiographic evidence.

17.3.2 Production Radiography

Only Level II or III radiographers shall interpret the radiographic images of production welds. As soon as radiographs are taken, they shall be developed and dried and interpreted by the T&I CONTRACTOR. Thereafter all radiographs shall be submitted to EPC CONTRACTOR/ CLIENT for examination and approval.

With each batch of radiographs submitted to CLIENT for examination and approval, T&I CONTRACTOR shall give a list of the radiographs in duplicate. This list shall contain the T&I CONTRACTOR's interpretation of each radiograph. The radiography list shall be clearly marked to show which welds are repairs or re-welds. EPC CONTRACTOR/ CLIENT will state on this list the acceptability, or otherwise, of the weld.

EPC CONTRACTOR/ CLIENT shall state whether the weld has passed, is to be repaired, is to be cut out, or requires additional NDT. T&I CONTRACTOR shall

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repair or cut out and re-weld the welds, or carry out additional NDT in accordance with the statements on the list returned to him.

17.3.3 Identification of Radiographs

Radiographs shall be clearly identified by the use of lead numbers, letters or markers and as a minimum, the film identification shall include:

- Project identification (as previously agreed with EPC CONTRACTOR/ CLIENT);
- Line size and identification;
- Joint number;
- Date (day, month and year);
- Radiographic location;
- Welder number;
- Radiation source;
- Intensifying screens;
- Film;
- Exposure geometry;
- Exposure conditions;
- Processing;
- Materials;
- IQIs; and
- Heat shields.

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.

All radiographs shall be clearly identified with reference to the welds they represent. All measurements used for defect location shall be stated in metric units.

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

17.3.4 Radiograph Processing

On-site administration, storing and recording of radiographic films prior to and after exposure shall be T&I CONTRACTOR's responsibility. Conditions of storage,

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temperature and humidity shall comply with the recommendations of the film and chemical manufacturers.

Before completion of the project, all exposed film shall be indexed, catalogued, boxed up and handed over to EPC CONTRACTOR/ CLIENT in accordance with EPC CONTRACTOR/ CLIENT 's requirements.

17.3.5 Processing Area

The image processing room and all accessories therein shall be equipped to handle the processing of all radiographs taken and shall be kept clean and dust free at all times. As a minimum, all films shall be protected in individual plastic bags and stored in aluminium boxes closed with tight fit lids before delivery to EPC CONTRACTOR/ CLIENT. All film boxes shall be individually numbered and indexed (arrangement of films to be stated) on their top.

Viewing illuminators shall be used which shall produce light of sufficient intensity, so that all portions of the radiograph of the weld and base metal will transmit sufficient light to reveal the pertinent details of the radiograph. The light intensity shall be compatible with the density of the radiograph specified herein.

One radiograph in every 100 shall be subjected to a test to ensure that the film has been suitably processed for five (5) years storage.

17.3.6 Radiation Protection

T&I CONTRACTOR shall be responsible for the protection of all persons in the vicinity of the radiographic equipment.

T&I CONTRACTOR shall satisfy EPC CONTRACTOR/ CLIENT that all aspects of relevant safety procedures are adequately covered and have been implemented.

T&I CONTRACTOR shall identify the areas where radiography is being performed by means of signs, symbols, etc. and shall be responsible for the policing of such areas.

17.3.7 Standards of Acceptance for Radiographic Testing

Standards of acceptance shall be as specified in API Standard 1104, except that the following shall not be permitted:

- Cracks;
- Projection of unfused filler;
- Inadequate penetration;
- Incomplete root fusion;
- Copper inclusions; and

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- Tungsten inclusions with a width exceeding 3mm or 50% of the wall thickness, whichever is smaller.

Undercut comparator shims shall be used to measure internal undercut.

Indications that the pipe material next to the weld has been damaged in any way (e.g. mechanical damage, weld beads, defects in the longitudinal seam of longitudinally welded pipe, etc.) shall be reason to reject the weld.

17.4 ULTRASONIC EXAMINATION

17.4.1 Automatic Ultrasonic Testing

Before Automatic Ultrasonic examination is carried out, T&I CONTRACTOR shall qualify the equipment and testing procedures and the results shall be submitted for EPC CONTRACTOR/ CLIENT's approval.

Ultrasonic Operator shall be certified in accordance with ASNT Level II/Level III or EPC CONTRACTOR/ CLIENT approved equivalent. EPC CONTRACTOR/ CLIENT reserves the right to test proposed UT operator prior to acceptance using approved procedures on test weld.

Automatic ultrasonic inspection shall be performed in accordance with EPC CONTRACTOR/ CLIENT approved detailed procedure. The procedure must be prepared and approved by a Level III operator in ultrasonic method.

The Ultrasonic examination shall be performed by personnel holding at least ASNT level II qualification under the supervision of personnel holding ASNT level III qualification.

For production weld inspection, T&I CONTRACTOR shall provide a mechanized ultrasonic inspection procedure that allows for full volumetric examination of a weld in a single pass, from both sides of the weld. The procedure shall provide for reliable detection and characterization of all relevant indications in the pipeline girth welds. The determination of indication acceptability must include the ability to accurately locate and size, to within ± 1 mm, all linear and volumetric indications and determine interaction of potential defects.

17.4.2 UT Acceptance Criteria

All indications that produce a response greater than 20% of the reference level shall be investigated to determine the location, shape, extent and type of reflectors and shall be evaluated according to the following criteria:

- All linear indications interpreted to be cracks are unacceptable;
- LS indications (other than cracks) interpreted to be open to the ID or OD surface shall be considered defects should any of the following conditions exist:

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- a) Individual indications with height exceed lesser of 0.2 Tw or 3.0mm. Where Tw is the pipe wall thickness;
 - b) Individual indications have reflection amplitude exceed reference amplitude + 6dB;
 - c) Individual indications with length between Tw and 25mm and have reflection amplitude exceed reference amplitude. Where Tw is the pipe wall thickness;
 - d) Indications that above reference amplitude level have aggregate length exceed 25mm in any continuous 300mm of weld length;
 - e) Indications that above reference amplitude level have aggregate length exceed 8% of weld length.
- Linear indications (other than cracks) interpreted to be buried within the weld are unacceptable if they exceed 50mm in length, or if they exceed 50mm in total length in a continuous 300mm length of weld, or if they exceed 8 percent of the weld length.

For repair welding inspection, T&I CONTRACTOR shall provide a mechanized ultrasonic inspection procedure that allows for full volumetric examination of a weld in a single pass from both sides of the weld. The procedure shall provide for characterization of defects and their location to the requirement of API Standard 1104.

Test details, including a notation of all defects along with a hard copy recording of the inspection shall be submitted to EPC CONTRACTOR/ CLIENT for approval. EPC CONTRACTOR/ CLIENT shall notify T&I CONTRACTOR of its approval of each procedure and/or technique validated. Upon the approval from EPC CONTRACTOR/ CLIENT, the procedure becomes mandatory requirements and changes are permitted with further approval from EPC CONTRACTOR/ CLIENT.

T&I CONTRACTOR shall submit ultrasonic reports to EPC CONTRACTOR/ CLIENT's Representative on an ongoing basis on the barge. No weld shall be moved past repair station unless AUT report is complete and the weld is judged satisfactory by EPC CONTRACTOR/ CLIENT's Representative.

T&I CONTRACTOR shall maintain ultrasonic reports as directed by EPC CONTRACTOR/ CLIENT using pre-approved forms.

All completed hard copy graphs shall be catalogued and packed by T&I CONTRACTOR. Boxes of hard-copy graphs shall be numbered sequentially.

Back-ups of all digital data shall be made immediately after the weld has been scanned, the data analyzed, and the weld accepted or rejected, with a minimum of 2

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back-ups of each file on separate storage media. The system hard disc shall not be considered as back-up.

At the completion of the project, all electronic data files shall be archived on CD-ROM and presented to the EPC CONTRACTOR/ CLIENT.

17.5 MAGNETIC PARTICLE INSPECTION

T&I CONTRACTOR shall supply a Magnetic Particle Inspection (MPI) Procedure for review and approval by EPC CONTRACTOR/ CLIENT.

Magnetic Particle examination is required for the following activities:

- Re-bevelling due to pipe damage and/or cut outs;
- After arc gouging and grinding of weld repair exactions and prior to repair welding;
- On the completion of weld repairs;
- On removal of arc strikes.

MPI operators shall be qualified in accordance with ASNT-RP-SNT-TC-1A or approved procedure.

EPC CONTRACTOR/ CLIENT reserves the right to test the proposed MPI procedure prior to acceptance, using the approved procedures.

17.6 ACCEPTANCE STANDARDS FOR NON-DESTRUCTIVE TESTING

The acceptance criteria shall be in accordance with API Standard 1104 and supplementary requirements in section 17.3.7 and section 17.4.2.

API Standard 1104 Annex A – Alternative Acceptance Standards for Girth Welds may be used only if accepted in writing by EPC CONTRACTOR/ CLIENT.

17.7 PERSONNEL QUALIFICATION REQUIREMENTS

All inspection and NDE operator certifications/qualifications shall be submitted to EPC CONTRACTOR/ CLIENT for review and approval.

All inspectors shall be validly certified Inspectors (AWS CWI/ SCWI, CSWIP 3.1/ 3.2 or acceptable equivalent) except specialty technicians (PT, MT, UT or RT) who shall be qualified and certified according to the guidelines of ASNT SNT-TC-1A or equivalent. EPC CONTRACTOR/ CLIENT reserves the right to proficiency test (at no additional cost to EPC CONTRACTOR/ CLIENT) any NDE operative working for T&I CONTRACTOR irrespective of their current qualifications. The test shall comprise a practical demonstration of NDE operator capabilities together with ability to evaluate and report the work relative to the duties for which they are employed.

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18. ENGINEERING CRITICAL ANALYSIS (ECA)

ECA implementation is optional for the pipeline T&I CONTRACTOR, if implemented, it must follow one of the following options: Option 1, 2, or 3, as specified in Annex A of API 1104.

The Engineering Subcontractor responsible for conducting the methodology, analysis, calculations, desktop study, and reporting for the entire ECA shall be approved by the EPC CONTRACTOR/ CLIENT prior to selection.

Mechanical testing, such as CTOD, must also comply with Annex A of API 1104. It is assumed that the effects of H₂S may be excluded from the ECA, given the current H₂S levels. The CONTRACTOR shall seek confirmation from the COMPANY regarding this assumption.

The maximum allowable flaw sizes shall be determined by the ECA. This will be subject to the restriction that the actual height of individual (non-interacting) planar flaws must meet the workmanship criteria specified in Annex A of API 1104.

Since the ECA has been approved by the EPC CONTRACTOR/ CLIENT, it shall be used to develop the weld NDT acceptance criteria.

All costs associated with establishing the ECA shall be borne by the T&I CONTRACTOR.

19. REMOVAL AND REPAIR OF DEFECTS

19.1 GENERAL

All weld repairs shall be performed in accordance with a EPC CONTRACTOR/ CLIENT's approved and qualified weld repair procedure. Welds that fail to comply either wholly or in part with the requirements of this Specification shall be repaired or, if EPC CONTRACTOR/ CLIENT so requires, the weld shall be removed.

A repair method statement shall specify the welding procedure, method of examination of the defect area, removal technique, maximum size of excavation, and the method of preheat and interpass temperature measurement.

Repair at root shall be minimized and such repair subject to approval of the EPC CONTRACTOR/ CLIENT inspector on a case to case basis.

Weld repair to pipe or fitting body or bevel shall not be permitted.

Defects, except cracks, may be repaired without prior authorization from the EPC CONTRACTOR/ CLIENT. The repair of cracks shall not be permitted. Any weld found to contain a crack shall be completely removed and the pipe ends re-prepared.

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All repair welds shall be made using a low hydrogen process capable of producing diffusible hydrogen equal to or less than 5 ml/100 g as measured by the AWS A4.3 method.

When arc air gouging is used, the gouged area shall be cleaned by grinding to be bright metal prior to welding.

Arc strikes shall be removed by grinding in accordance with ASME B31.8. Remaining pipe wall thickness after grinding shall be confirmed to meet API Specification 5L limits by ultrasonic thickness meter.

No more than two separate repair areas shall be permitted in the circumference of any weld. A third repair area shall require the removal of the complete weld and re-bevelling of the two pipe ends prior to re-welding. This section of pipe shall be a minimum of 100mm long centred on the weld. The removed section shall remain the property of the EPC CONTRACTOR/ CLIENT and shall be permanently marked with an identification number.

Second repair in a previously repaired area of a completed weld shall not be permitted unless it is specifically authorized by the EPC CONTRACTOR/ CLIENT and repaired with a qualified repair procedure appropriate for the number of thermal cycles used.

When partial removal of the weld is approved, the cut out portion shall be a minimum of 50mm long and sufficiently deep and long to completely remove the defect. At the ends and side of the cut there shall be a gradual taper from the base of the cut to the surface of the weld metal. The width and profile of the cut shall be such as to give adequate access for re-welding.

For procedures based on carbon steel groove welding procedures, work piece temperature shall be a minimum of 100°F (38°C) higher than the minimum preheat temperature required for the original approved welding procedure.

Repair welds shall be qualified by making a full thickness repair weld according to the following description: T&I CONTRACTOR shall make a complete weld following the accepted production welding procedure. This weld shall be gouged out leaving the nipple with one side (50%) original weld and original HAZ. A repair weld (full thickness) shall then be completed in the repair excavation and the resultant weld subjected to the same NDE and mechanical testing as the original weld. Similar scenario shall be repeated for a mid thickness repair on a separate test nipple with the same NDE and mechanical test criteria. Cap repairs will be demonstrated on a similar test nipple with exception that the only mechanical test be limited to hardness survey.

Open root repairs shall not be made after the last tensioner for offshore pipeline welding unless a stress analysis is performed by T&I CONTRACTOR and approved by EPC CONTRACTOR/ CLIENT.

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All welds repairs shall be re-inspected using the same inspection technique and requirements as for the original weld.

19.2 RECORD OF REPAIRS

A full record of all repairs shall be maintained by T&I CONTRACTOR. The record shall include, as a minimum, the following:

- Weld number;
- Type and size of defect;
- Circumferential location (defined to an approved system);
- Estimate of the depth (assessed by ultrasonic test where possible);
- Where possible, the name of the welder who produced the defect;
- Repair welding procedure number;
- Name of repair welder;
- Copy of the inspection report for the repair which include full detailed and documented parameter check, pre-heat temperature, interpass temperature and heat inputs with amps/volts and travel speeds; and
- Date of repair.

20. MATERIAL CONTROL AND TRACEABILITY

20.1 SUBSTITUTION OF MATERIALS

Substitution of materials not meeting this specification and not approved in writing by EPC CONTRACTOR/ CLIENT shall not be accepted.

Non-conforming materials shall be removed and replaced with the specified materials. Material substitution requests shall be submitted in writing to EPC CONTRACTOR/ CLIENT for approval, allowing reasonable time for evaluation without disruption of the schedule.

Material substitution requests shall include:

- Nature and extent of the substitution;
- Complete material specifications;
- Mechanical and physical properties of proposed substitute;
- Other information requested by EPC CONTRACTOR/ CLIENT.

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20.2 MATERIAL TRACEABILITY

T&I CONTRACTOR shall establish a procedure to document and provide traceability of all primary materials to their original mill certifications. The procedure shall identify methods for maintaining the identity of material from manufacturing stages through transport, receipt, storage, and final component fabrication.

Before materials are cut, permanent identification (heat/pipe numbers) shall be transferred.

Each weld shall be marked with the identification symbol of the welder or welding operator next to the weld area or records shall be maintained to identify the work of each welder, i.e., weld numbers, shift, passes, left or right side of pipe, etc. Failure to use the symbol or maintain adequate records shall be cause for rejection of the work and removal of the weld.

A system shall be employed for linking unique pipe numbers, inspection records, weld numbers, and welder identification.

20.3 STORAGE OF MATERIALS

Structural materials, whether plain or fabricated, shall be stored above ground on flat surfaces or platform type skids or on other EPC CONTRACTOR/ CLIENT approved supports.

Materials shall be kept free of dirt, grease, paint spray, or other foreign matter and shall be protected from corrosion.

Welding filler metals shall be stored in un-opened containers until use. Filler materials from broken or damaged containers shall not be used.

Low hydrogen electrodes shall be stored in an appropriate rod oven after opening the container. Cellulose coated electrodes shall be kept clean and dry but shall not be store in a rod oven.

20.4 REPORTS AND RECORDS

The reports and data listed in Section 21 shall be supplied to EPC CONTRACTOR/ CLIENT's Representative.

Additionally, T&I CONTRACTOR shall retain the radiographic film, a copy of the examination procedures, and personnel qualifications used for the contracted work for five (5) years or according to the contract requirements.

21. DOCUMENTATION

T&I CONTRACTOR shall prepare three hard copies and one soft copy (PDF format) for every set of documents and procedures etc to be submitted for EPC CONTRACTOR/ CLIENT's review and approval. The minimum engineering documents required but not limited to the following:

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- EPC CONTRACTOR/ CLIENT approved welding procedure;
- Inspection and Test Plan;
- Inspection and Test Procedure;
- Material Traceability System;
- Welding System Specification;
- Welding Procedure Specification and Qualification (WPS and WPQ);
- Weld Consumable Handling Procedure;
- Welding Training Procedure;
- Welders Qualifications;
- Weld Summary Sheet identifying all WPSs and processes;
- Mechanical Testing Procedures and Testing Laboratory Details;
- Consumable Batch Testing Records;
- Qualification Test Record;
- Performance Records;
- Equipment Calibration Records;
- NDE/NDT Procedures and Qualification;
- NDE/NDT Reports and Results;
- NDE/NDT Operators Qualification;
- Radiographic Film;
- Non-conformance / Discrepancy Reports and Final Dispositions;
- Weld Repair Maps;
- Welding Parameter Checks;
- Heat Treatment Time Temperature Report (If any);
- As Built Records.