ADNOC GROUP PROJECTS AND ENGINEERING

REINFORCEMENT THERMOPLASTICS PIPELINES

Specification

AGES-SP-10-005

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GROUP PROJECTS & ENGINEERING / PT&CS DIRECTORATE

CUSTODIAN	Group Projects & Engineering / PT&CS
ADNOC	Specification applicable to ADNOC & ADNOC Group Companies

Group Projects & Engineering is the owner of this Specification and responsible for its custody, maintenance and periodic update.

In addition, Group Projects & Engineering is responsible for communication and distribution of any changes to this Specification and its version control.

This specification will be reviewed and updated in case of any changes affecting the activities described in this document.

INTER-RELATIONSHIPS AND STAKEHOLDERS

a) The following are inter-relationships for implementation of this Specification:
   i. ADNOC Upstream and ADNOC Downstream Directorates and
   ii. ADNOC Onshore, ADNOC Offshore, ADNOC Sour Gas, ADNOG Gas Processing. ADNOC LNG, ADNOC Refining, ADNOC Fertilisers, Borouge, Al Dhafra Petroleum, Al Yasat

b) The following are stakeholders for the purpose of this Specification:
   ADNOC PT&CS Directorate.

c) This Specification has been approved by the ADNOC PT&CS is to be implemented by each ADNOC Group company included above subject to and in accordance with their Delegation of Authority and other governance-related processes in order to ensure compliance

d) Each ADNOC Group company must establish/nominate a Technical Authority responsible for compliance with this Specification.

DEFINED TERMS / abbreviations / References

"**ADNOC**" means Abu Dhabi National Oil Company.

"**ADNOC Group**" means ADNOC together with each company in which ADNOC, directly or indirectly, controls fifty percent (50%) or more of the share capital.

"**Approving Authority**" means the decision-making body or employee with the required authority to approve Policies & Procedures or any changes to it.

"**Business Line Directorates**" or "**BLD**" means a directorate of ADNOC which is responsible for one or more Group Companies reporting to, or operating within the same line of business as, such directorate.

"**Business Support Directorates and Functions**" or "**Non- BLD**" means all the ADNOC functions and the remaining directorates, which are not ADNOC Business Line Directorates.

"**CEO**" means chief executive officer.

"**Group Company**" means any company within the ADNOC Group other than ADNOC.

"Specification" means this specification.

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I INTRODUCTION

I.1 Scope

This specification is an amendment and supplement to API SPEC 15S (Spoolable Reinforced Plastic Line Pipe), the purpose of this specification is to define the requirements for selection, engineering, construction and maintenance for utilizing non-metallic spoolable Reinforcement Thermo-Plastic (RTP) for different pipeline services.

This specification defines the minimum requirements of material properties, design, manufacture, factory testing and inspection, storage, transportation, site preparation, fabrication, installation and field testing for the Reinforcement Thermoplastic (RTP) Underground and Aboveground pipeline installation. Also this specification covers the minimum pre-qualification requirements of EPC CONTRACTORs, Subcontractors and Engineering Consultants aimed to carry out above mentioned activities.

This specification highlights some important requirements extracted from lessons learned related to design, types of joints, quality control, construction and pre-commissioning without over-ruling the responsibilities of Engineering Consultant, EPC CONTRACTOR and RTP Pipe manufacturer to introduce the best engineering, supply and construction practices.

RTP material shall follow the technical specification as mentioned in API SPEC 15S for all mandatory and optional requirements in addition to technical points in this specification.

Section II of this document consists of ADNOC quality assurance requirements

Section III is the technical requirements based on ADNOC Onshore experiences and API SPEC 15S, which defines a minimum common set of supplementary requirements for the specification for design, testing, inspection and procurement of Reinforcement Thermo-Plastic Pipeline.

This Engineering Specification shall be referred in the relevant project documents issued to the Consultants / CONTRACTORs for the utilization of Reinforcement Thermoplastic Pipelines.

This specification shall generally apply to:

I Produced Water, Water Injection, Water Supply and Disposal flowlines.

II Natural Oil production, ESP and Gas Lift Oil production flowlines.

III Dry fuel gas flowlines and pipelines (6in and below).

Notes:

1. RTP pipeline size is limited up to 6in diameter based on the economical, manufacturing and transportation limitations.
2. Internal layer selection shall be based on the maximum operation temperature and resistance to residual chemicals of downhole (if any).

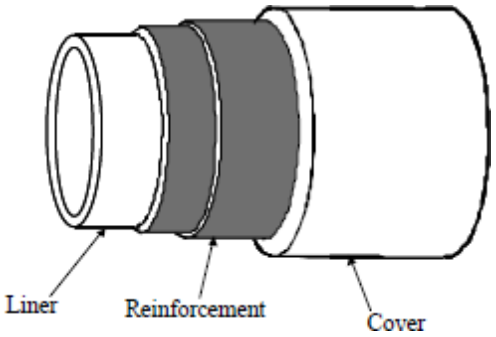


Fig. 1 RTP pipe composite structure

This document replaces the following ADNOC Onshore pipeline specification ES-30-99-12-0037.

This specification is covering the battery limits of RTP flowlines systems up to the tie in with metallic piping system in wellhead and stations in Onshore sites and Islands; Material Specification and construction of aboveground metallic piping and connections design are not part of this specification.

All requirements listed in this document are applicable irrespective of final location.

I.2 Exclusion

This Specification does not cover other non-metallic material such GRE and Polyethylene for pipeline systems.

This specification shall not apply to plant piping systems.

I.3 Definition, Abbreviations and References

I.3.1 General Definitions

COMPANY	Abu Dhabi National Oil Company or any of its Upstream, Midstream and Downstream Operating Companies working in UAE; while the other commonly used terms are ;Owner, End User, Purchaser, Operator, Client, Customer or Appointed Representative.
CONTRACTOR	The party who carries out all or part of the design, engineering, procurement, construction, commissioning or management of the project
Consultant	The specialist party who carry out design of RTP Pipeline from Process, Material Selection and Mechanical disciplines.
VENDOR/ SUPPLIER	The party that manufacturers or supplies equipment and services to perform the duties part of the project.
Third Party Agency	The agency or agencies appointed or nominated to certify the equipment or parts thereof by reference to the standards given in all relevant designs, specifications or procedural documents.
May	Used where alternatives are equally acceptable.
Should	Indicates a strong recommendation to comply with the requirements of this document.
Shall	Indicates mandatory requirement.

Acceptance Criteria	Defined limits placed on characteristics of materials, products or services.
Inspector	Individuals / party designated by the COMPANY to act on behalf of the COMPANY for monitoring CONTRACTOR's quality control testing and technical acceptance.
HDPE	Generic group name of polyethylene that come in different grades or strength classes like: PE-80, and PE-100.
PE-RT	PE-RT or PET is a High Density Polyethylene product mainly modified for Raised Temperature applications. Its temperature can withstand from 80 OC up to 110 OC depend on the reinforced additives.
PA-12	Also known as Polyamide 12 or Nylon 12; is a good general-use plastic with broad additive applications and is known for its toughness, tensile strength, impact strength and ability to flex without fracture. PA-12 has also modified products by glass reinforced PA-12 GF and carbon fiber reinforced PA-12 CF.
PVDF	Polyvinylidene fluoride or polyvinylidene difluoride (PVDF) is a highly non-reactive thermoplastic fluoropolymer produced by the polymerization of vinylidene difluoride. PVDF is a specialty plastic used in applications requiring the highest purity, as well as resistance to solvents, acids and hydrocarbons.
PPS	Polyphenylene sulfide is a partially crystalline, high temperature performance polymer. This polymer has a high melting point of approximately 280°C, excellent chemical resistance and is inherently flame retardant. It offers an excellent balance of properties, including high temperature resistance, flowability, dimensional stability and electrical characteristics.

I.3.2 Abbreviations

ADNOC	Abu Dhabi National Oil COMPANY
AON	Abu Dhabi COMPANY for Onshore Petroleum Operations COMPANY Ltd.
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing And Materials
AVL	Approved Vendor List
CDS	Central Degassing Station
CP	Cathodic Protection System
CS	Carbon Steel
DPI	Dye Penetrant Inspection
DSC	Differential scanning calorimetry
EN	European Norms (Standards)
EPC	Engineering Procurement Construction
ES	Engineering Standard Specification
FAT	Factory Acceptance Test
FEED	Front End Engineering Design
FST	Full Scale Test

ESD	Emergency Shut-Down
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
HSCR	High Stress Crack Resistant
HSE	Health Safety and Environment
ICSS	Integrated Control and Safety System
ISO	International Organization for Standardization
ITP	Inspection and Test Plan
LTHS	Long Term Hydrostatic Strength
MCR	Mechanical Calculation Report
MFR	Melt Mass-Flow Rate
MJ	Mechanical Joint
MRS	Minimum Required Strength
NACE	National Association of Corrosion Engineers
NFPA	National Fire Protection Association
NOC	Non Objective Certificate
OD	Outside Diameter
OIT	Oxidation Induction Time
PE	Polyethylene
PE-RT	Polyethylene Raised Temperature
PN	Nominal Pressure
PPS	Polyphenylene Sulfide
PPI	Plastic Pipes Institute
PQR	Procedure Qualification Record
PVDF	Polyvinylidene Fluoride or Polyvinylidene Difluoride
QA	Quality Assurance
RCP	Rapid Crack Propagation
RFQ	Request For Quotation
ROW	Right of Way
RSB	Regulation Supervision Bureau
RTP	Reinforced Thermo-Plastic
SAT	Site Acceptance Test
SDR	Standard Dimension Ratio
SDRL	SUPPLIER Data Requirements List
SRB	Sulfate reducing bacteria
SS	Stainless Steel

WIS	Water Industry Specification
WPS	Welding Procedure Specification

I.4 References

I.4.1 Standard Specification and Guidelines

The engineering, supply and installation of the equipment/ package shall be in compliance with the engineering standard specifications list hereunder; as applicable.

AGES-GL-07-001	Material Selection Guidelines
AGES-SP-10-003	Pipeline Design and Construction Guidelines
AGES-SP-01-017	Pipeline Bund, Berm, Anchor Blocks and ROW Construction (1)
AGES-SP-01-011	Topographic/Geophysical Survey & Mapping (1)
ES 30-99-90-0006 (AON)	Project Quality System Requirements (2)
General-30-99-00-8517-1 (AON)	Equipment and Material Criticality Rating (2)

(1) Documents are under preparation of Standards Rationalization Project. OPCO's standard specifications can be utilized till the completion of standard specifications.

(2) Documents are under development within ADNOC Group (AGES-SP-13-001) to include the non-metallic materials. However, each company can utilize its own specification till final unified specification are officially released.

I.4.2 International Codes

ASME BPVC	Section V, Non-destructive Examination
API SPEC 15S	Spoolable Reinforced Plastic Line Pipe
API SPEC 15 HR	Specification for high pressure fiberglass line pipe
API SPEC 15LE	Specification for Polyethylene Line Pipe (PE)
ASTM C177	Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
ASTM C581	Standard practice for determining chemical resistance of thermosetting resins used in glass-fiber reinforced structures intended for liquid service.
ASTM D1598	Test method for time-to-failure of plastic pipe under constant internal pressure
ASTM D1599	Test method for short-time hydraulic failure pressure of plastic pipe, tubing, and fittings.
ASTM D2105	Standard Test Method for Longitudinal Tensile Properties of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Tube

ASTM D2969	Standard Test Methods for Steel Tire Cords
ASTM D3567	Standard Practice for Determining Dimensions of Fiberglass (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings
ASTM D570	Standard Test Method for Water Absorption of Plastics
ASTM D1044	Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion.
ASTM D1525	Standard Test Method for Vicat Softening Temperature of Plastics
ASTM D1599	Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings
ASTM D2143-00	Standard Test Method for Cyclic Pressure Strength of Reinforced, Thermosetting Plastic Pipe
ASTM D4060	Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM E831	Standard Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis
ASTM E1269	Standard Test Method for Determining Specific Heat Capacity by Differential Scanning Calorimetry
ASTM F412	Standard Terminology Relating to Plastic Piping Systems
DNV-RP-F109	On-Bottom Stability Design of Submarine Pipelines
DNV-ST-F101	Submarine Pipeline Systems
ISO 1172	Textile Glass Reinforced Plastics - Determination of Loss on Ignition
ISO 23936-1 & 2	Petroleum, petrochemical and natural gas industries—Non-metallic materials in contact with media related to oil and gas production – Part 1: Thermoplastic and Part 2: Elastomers
ISO 9001	Quality Management Systems Requirements
ISO14001	Environmental Management Systems Requirements
ISO 45001	Occupational Health and Safety Management Systems Requirements
NACE TM0284-2011,	Evaluation of Pipeline and Pressure Vessel Steels for Resistance to Hydrogen-Induced Cracking
NORSOK M-710	Qualification of non-metallic sealing materials and manufactures
PPI TR-4, PPI	Listing of Ratings for Thermoplastic Piping Materials or Pipe
PPI TR-19	Chemical Resistance of Thermoplastics Piping Materials

II QUALITY ASSURANCE

II.1 Scope

Inspection certificate 3.2 in accordance with EN 10204 is required for all pipes.

The manufacturer shall operate a Quality Management System (QMS) within his organization, which ensures that the requirements of this Specification are fully achieved.

The Manufacturer shall have activated quality system in compliance at least with ISO 9001, ISO 29001, and API Q1 and accredited by API 15S.

To specify quality management requirements for the supply of RTP Pipeline Supplementary Specification to API Specification 15S including:

a) manufacturer quality management system requirements;

b) purchaser conformity assessment (surveillance and inspection) activities;

c) traceability requirements;

d) evidence of conformance

II.2 Normative References

For the purpose of this document the documents referenced in quality requirements DOC. Ref. No. 30-99-97-0006 (AON) latest version and those listed below, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9001:2015	Quality management systems - Requirements
API Specification Q1	Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry
ISO 29001: 2018	Petroleum, petrochemical and natural gas industries — Sector-specific quality management systems — Requirements for product and service supply organizations

II.3 Terms and Definitions

For the purpose of this document, the terms and definitions given in 30-99-97-0006 (AON) and subsequently ISO 9000:2015 (normative to ISO 9001) and the following shall apply.

II.4 Conformity Assessment

Demonstration that requirements relating to a product, process, system, person or body are fulfilled.

Note 1 Conformity assessment (or assessment) includes but is not limited to review, inspection, verification and validation activities.

Note 2 Assessment activities may be undertaken at a manufacturer's or sub-manufacturer's premises, virtually by video link, desktop sharing, etc. or by review of information formally submitted for acceptance or for information.

II.5 Conformity Assessment System (CAS)

Systems providing different levels of assessment of the manufacturer's control activities by the purchaser (second-party) or independent body (third-party) based on evaluation of the manufacturer's capability to conform to the product or service specification and obligatory requirements.

Note CAS A reflects the highest risk and associated extent of verification.

II.5.1 Conformity assessment – hold point (H)

The point in the chain of activities beyond which an activity shall not proceed without the approval of the purchaser/purchaser's representative.

II.5.2 Conformity assessment – witness point (W)

The point in the chain of activities that the manufacturer shall notify the purchaser/purchaser's representative before proceeding. The operation or process may proceed without witness if the purchaser does not attend after the agreed notice period.

II.5.3 Conformity assessment – surveillance (S)

Observation, monitoring or review by the purchaser/purchaser's representative of an activity, operation, process, product or associated information.

II.5.4 Conformity assessment – review (R)

Review of the manufacturer's information by the user or the user's representative to verify conformance to requirements.

Note Information review requirements are managed on a surveillance basis and as such do not impose schedule constraints, unless specified as hold points as conditions specified in the associated ITP.

II.5.5 Critical

That deemed by the manufacturer, product specification, or purchaser as mandatory, indispensable or essential, needed for a stated purpose or task, and requiring specific action.

II.5.6 Symbols and abbreviations

For purposes of this document, the following symbols and abbreviations apply:

CAS conformity assessment system

II.6 Quality Requirements

II.6.1 Quality Management System

The manufacturer shall demonstrate that the quality management arrangements established for the supply of products and services conform to ISO 9001, API Specification Q1 or an equivalent quality management system standard agreed with the purchaser.

All manufacturing and site installation shall be in accordance with quality requirements DOC. Ref. No. 30-99-97-0006 (AON) latest version

The manufacturer's quality management system shall be based on the latest issue of ISO 9001 (or an equivalent) and accredited by a reputable certifying agency. The manufacturer's quality manual shall provide details for the preparation of a quality plan, which shall include provisions for the QA/QC of all raw materials, pipe manufacture, testing and final inspection. Where an approved Manufacturer revises their Quality Management system that effect any changes to COMPANY approved Quality plan / Inspection & test plan, then the revised Quality plan / Inspection & test plan shall be submitted for COMPANY approval before initiating any manufacturing process.

The effectiveness of this quality system may be subject to monitoring by the COMPANY or its representative and may be audited following an agreed period of notice.

The manufacturer shall maintain sufficient Inspection and Quality Assurance staff, independent of his production management, to ensure that the Quality plan is correctly implemented and that all related documentation is available.

The manufacturer shall not deviate from specified materials or substitute sources of material supply without prior written consent of technical authority from COMPANY.

Pre-production meetings shall be held between the COMPANY and/or its representatives and the manufacturer, to clarify and resolve any technical issues.

The first pre-production meeting shall be conducted within 14 days after the award of Purchase Order.

Project quality plan (PQP) and inspection test plan (ITP), along with all referenced procedures shall be approved by at least 4 working weeks before production commencement. In addition, at least the following documents and records:

- The products regression curves for pipes, fittings, and connections … etc.
- Track records of similar orders for the last 3 years including the following details; product, service conditions, pipe geometry, produced quantity … etc.
- Technical specifications for resourced raw materials.
- Procedure for non-conformance analysis and corrective actions implementation
- Manufacturing procedure specification (MPS).

Any approved document shall not be modified without the written approval of the COMPANY ,all procedures listed in the MPS and ITP shall be made available to the

COMPANY for review and comments, manufacturer shall submit for review & approval any deviations to the requirements specified in all applicable technical documents referenced herein.

Just before production commencement, the head of manufacturers' quality with ADNOC Representative, and TPI (as applicable) shall check and review all involved production and inspection stages , and assure that the relevant working instructions and procedures are available, complete in conformance with applicable the approved specifications and this document. A report by manufacturers shall be issued, endorsed and filled in the final dossier.

All procedures shall have prior approval by COMPANY, and all qualification tests shall take place under the supervision of the COMPANY.

Manufacturer shall notify the COMPANY's representative sufficiently in advance to enable him to present at qualification tests and at all other tests/stages of manufacturing which subjected to acceptance in accordance with the specifications.

The manufacturer shall provide COMPANY's representative with full and free access to all parts of the production facility as well as to all information; records and documents relevant to the purchase order under process .all information shall be in English language.

COMPANY's representative shall ensure that materials and pipes are manufactured in accordance with all specified requirements and approved procedures.

Manufacturer shall provide free access to COMPANY's representative for the following information:

- Tracking system of production and inspection
- All data and results of mechanical tests and NDE results
- Any other information considered pertinent by Company's representative as per ITP and referenced procedures
- COMPANY's representative will notify the COMPANY immediately for any difficulty, irregularity, problem, or delay likely to occur during pipe production
- The COMPANY reserves the right to check tests carried out by the manufacturer, consequently the COMPANY may request the delivery of the corresponding samples or specimens to be analyzed in independent laboratory chosen by the COMPANY any on cost of the manufacturer.

End caps and surface protection shall be put in place before shipping, spools shall be set within a structure protecting the pipe from any mechanical damage .pipe protection against moisture and UV shall be ensured.

RTP manufacturers shall provide the following to COMPANY Technical Authorities for review and technical assessment:

1- Vendors Quality Control and Assurance Manuals.

2- Technical data sheets of each type of non-metallic materials including full technical description, tests, range of applications, services, limitations, sour / non-sour, single / multiphase fluids, metallurgical & mechanical specifications… etc.

3- Certificates and monograms.

4- Details of Product Lab tests (for Gas & Liquid Sour Hydrocarbon) approved from an international recognized labs. The minimum required tests shall be as the following:

   a. Burst Test
   b. Falling Weight Impact Test
   c. Hydrotest Pressure Test
   d. Permeation Test (Using hydrocarbon gas at temperatures 50, 60, 70 and 85 ^{O}C based on the liner & aramid material specification).
   e. Rapid Gas Decompression.
   f. HIC & SSC tests for steel reinforcement.
   g. All tests as mentioned in API 15S.

5- Samples from all test reports.

6- Material certificates.

7- Field tests and inspection methods and procedures.

8- Maintenance and repair procedures.

9- Samples of guarantee/warranty letters for this kind of products.

Audit reports from all suppliers and sub-suppliers shall be made available to COMPANY representative whenever requested.

Manufacturer shall not deviate from any part of the manufacturing plan without prior written approval from COMPANY.

CONTRACTOR shall submit the following documents for review and approval at least 4 weeks before site construction commencement:

- Jointing procedure
- Storage and handling procedure
- Laying above ground /underground procedure
- Handing and lifting drawings
- Trenching preparation details
- Laying drawings
- Site-assembly detailed procedure
- Construction operators qualifications and track records
- NDT procedure
- NDT examiners qualifications and certifications

- Hydrotest procedure
- Training and certification of installation crew
- Installation of pipeline at road crossing
- Protection of aboveground pipeline from external mechanical damages and vehicle crossing.

COMPANY reserves the right to reject any, or part, or all material and manufacturing anomalies where acceptance of the non-compliance is not adequately justified by the manufacturer's technical argument.

Manufacturing documentation shall be retained by the CONTRACTOR / MANUFACTURER and shall be handed over as part of the handing over of the project's documentation.

COMPANY shall approve the manufacturer's specification before to its application.

II.6.2 Conformance assessment

Quality plans and inspection and test plans developed as outputs to operational planning and control for the products and services shall define the specific controls to be implemented by the manufacturer and when applicable, their sub-manufacturers, to ensure conformance with the specified requirements.

Controls shall address both internally and externally sourced processes, products and services Quality plans and inspection and test plans shall include provisions for the purchaser's conformity assessment system as specified in the project approved ITP.

The manufacturer's performance in meeting the requirements will be routinely assessed during execution of the scope and where appropriate, corrective action requested and conformity assessment activities increased or decreased consistent with criticality and risk.

Irrespective of conformity assessment requirements defined by the purchaser, either, by reference to standard and specification requirements or in the scope, the manufacturer remains responsible for operational planning and control and demonstration of the conformity of products and services with the requirements (see ISO 9001:2015, 8.1 and 8.2).

II.6.3 Traceability

Material certification and traceability of starting material including billet, plate, coil and welding consumables and production inspection and testing results to finished pipe identification numbers shall be maintained in accordance with 30-99-97-0006 (AON).

II.6.4 Control of nonconforming products and services

Non-conformance with specified requirements identified by or to manufacturer prior to or during the delivery of the products and services shall be corrected such that the specified requirements are satisfied or the purchaser's acceptance of the non-

conformance agreed in accordance with purchase order conditions (see ISO 9001:2015, 8.2.3, 8.2.4, 8.5.6 and 8.7).

II.6.5 Evidence (conformance records)

Plans, procedures, methods and resultant records shall be provided in accordance with the associated ITP.

III TECHNICAL REQUIREMENTS

III.1 Design Basis of Flexible Pipeline

III.1.1 General

RTP pipes shall be designed and manufactured as per the specific requirements of the application which shall be listed in the FEED deliverables and/or technical requirements in the purchase order which shall be approved by COMPANY.

Materials of the RTP Pipelines shall be selected properly for services mentioned in clause I.1 and RTP Pipeline shall be designed based on the maximum and minimum operating conditions and fluid compositions during the design life of the pipelines. Cost and Operation study shall be considered during the selection of RTP layers' materials for harsh services to avoid high CAPEX and / or single source suppliers of the pipelines.

RTP Pipelines design basis shall follow Engineering Standard for Onshore Pipelines Design and Construction Specification AGES-SP-10-003 with additional requirements in this specification.

The following technical data shall be provided in the RTP vendor datasheet:

- Chemical composition of conducted fluid; e.g. oil, gas, water ... etc.
- Pressure limits including:
  1. Incidental pressure.
  2. Maximum allowable incidental pressure (MAIP).
  3. Maximum Operating Pressure.
- Maximum Operating temperature; which shall be confirmed by manufacturer.
- Type of pipe; e.g. number of layers and types of internal layer such as HDPE, PE-RT, PVDF … etc. including details of internal layer material compositions, mechanical and chemical properties and safety data sheet of internal layer.
- Cover Layer Material: HDPE type PE100 or PE80 can be utilized as cover layer unless manufacturer advocate better alternative which shall be subjected to COMPANY approval.
- Reinforcement Layer: Material, maximum hoop stresses, elongation factor, maximum elongation value … etc.

- Permeation Rate based on pipe design, material properties, fluid composition and process conditions.
- End connectors: materials, design, external coating or painting, type of fixation, testing, monogram, certificate … etc. Pipe to Pipe joining could be butt welding or electrofusion welding. However, other types of joints such as flanges, hub connectors … etc. can be utilized subject to project requirements, COMPANY approval and compliance with HSE requirements.
- Corrosion and Chemical Resistance and Limitations.
- Design life.
- Pipe Geometry: such as diameters (OD & ID), thicknesses, pipe cross section, end connectors, tie in connections … etc.
- External Mechanical Loads: maximum static and dynamic loads can be applied to the pipeline in case of road crossings, resistance to impact loads and maximum dead load can be applied due to sand accumulation and resistance to cyclic loading and corresponding amplitudes.
- Requirements of fire performance (if any).
- Requirements for static electricity check (if any).
- Requirements for low temperature application (if relevant).
- Requirements for beam deflection test (mainly for unburied pipelines).

III.1.2 Design Life

The design life of RTP Pipelines is directly related to the deterioration rate of internal layer and design life of UV material in the external layer. Basically design life of buried RTP Pipelines shall be above 30 years and the design life of surface laid (direct exposure to UV) RTP Pipelines shall be at least 20 years or higher.

RTP manufacturers shall prove and confirm that the flexible pipeline mechanical and metallurgical properties will remain within the design envelop during the design life of the facility as per the following parameters:

- Maximum and minimum operating pressures and temperatures.
- Different operating scenarios such as high and low production, upset conditions, depressurization of the pipeline … etc.
- Changing in reservoirs' conditions within the production profile such as increasing water cut, gases … etc.

III.1.3 RTP Material Requirements

Pipeline composite material selection shall be based on the recommendations of the resin manufacturers for the use of hardeners, catalysts and accelerators providing

technical data sheets, chemical resistance tests and mechanical tests as per reference codes of the resins to support the recommendations. RTP Pipeline manufacturers shall gather the required information for each fluid service to assure that the selected composite material is compatible with the fluid compositions and types of injected chemicals and biocides (if any).

Internal Layer material selection shall be based on the process data of required service fluid as per project specification; RTP vendor and designer shall make sure that selected material of internal layer will suit the application and service fluids during all over the design life of the pipeline. Material selection of internal and external layers of RTP pipes shall be based on and in compliance with ISO 23936-1

As COMPANY is operating multiple oil reservoirs and transport different fluids with different compositions, process data and surface facilities, the common factors between these oil reservoirs and services that the maximum operating temperatures are higher than 60 ^{O}C and multiphase hydrocarbon productions.

Accordingly the selected internal layer shall be qualified for multiphase hydrocarbon liquids with operating temperatures up to 85 ^{O}C (or higher based on the economic value).

RTP vendors shall select internal layer materials compatible with service fluid compositions, minimum and maximum operating temperatures at the time of installation and the expected changes in the service fluid operation. Internal layer shall be resistant to chemical reactions with different fluid compositions such as chlorine, biocides, chemical inhalators and demulsifiers or any other production chemical as e.g.HCl 15% (related to well intervention) shall be declared by internal layer manufacturers' technical data sheets and / or test reports based on project inputs by COMPANY. Internal layer material design shall be able to resist deformation and buckling due to the collapse forces generated during different modes of operations such as high & low production, well testing, shutdown and depressurization.

Whatever the reinforcement method employed for RTP pipeline, the temperature and chemical resistances are strongly linked to those of the inner liner material, since the strength of either metallic or non-metallic reinforcements should not be significantly affected by pipeline operating temperatures. As well the pipeline service fluid is isolated by the inner liner and does not directly contact the reinforcement layers other than through gas permeation. The chemical resistance of inner liner material within RTP pipe is an important consideration which RTP manufacturers shall provide the chemical limitations of the inner layer.

Composite pipeline shall be designed with minimum permeation of gases hydrocarbons up to 5ppm for non-toxic service and zero permeation for toxic services (containing H2S and CO2 or similar gases). The Coefficients for permeability, diffusivity and solubility shall be provided in RTP Pipeline Data Sheet for all service as per the project process design basis.

The effects of permeated gases (CO2, H2S and water vapour) on the metallic reinforcement structure materials long-term integrity shall be studied by RTP manufacturer; the outcomes shall be reviewed by COMPANY for approval.

Oxygen permeation from outside to inside the pipeline is not allowed for all types of services; accordingly manufacturers along with designer / engineering consultants shall provide and assure the adequacy of RTP Pipeline design to prevent Oxygen permeation into the pipeline.

Reinforcement material shall be designed based on maximum and minimum operating conditions, thermal expansion, stresses and external loads. Metallic and non-metallic reinforcement layers shall be compatible with service fluids to avoid degradation of material during the design life of the RTP Pipeline. Non-metallic reinforcement material shall be utilized for hydrocarbon sour service fluids while metallic reinforced shall be utilized for water service.

The RTP manufacturer shall have documented procedures for the winding of the reinforcing layers onto the pipe, which shall ensure that the layers are laid to the design requirements. The procedures shall include requirements for the condition of the reinforcement layers prior to winding and for the condition of the finished layer, such that the layer and underlying or overlying layers meet the manufacturer's specifications. No welding or jointing is allowed to the metallic or non-metallic reinforcement layers.

External layer of RTP Pipelines shall be capable to withstand the construction loads including friction forces with different types of terrain and environmental conditions. The manufacturer shall provide evidence of documented tests that the anti-wear layer performs its function, preventing wear between adjacent steel and / or extruded polymer layers, for the specified service life.

External layer shall be pigmented for all aboveground services, such as carbon black, or white pigment, e.g. rutile (Tio2) external pipe surface is UV resistant within the design life in accordance with ISO 11507. External layer for the buried service shall protected by a thermoplastic external layer, e.g. polyethylene, with at least 3 mm thickness.

lll.1.4 RTP Pipeline Design Requirements

RTP pipeline shall be designed to withstand the operational and environmental conditions where the pipeline is going to deployed in the field. The following technical considerations shall be considered during design of RTP:

i. Operational Conditions

- Reservoir Data: production profile for the reservoir life either new reservoirs or matured reservoirs including all the changes in produced fluids chemical compositions shall be considered in the material selection and design of RTP pipelines.
- Process Data: maximum and minimum pressures, temperatures and flowrates.
- Operation Scenarios: such as high and low production, shutdown, depressurization …etc.
- Chemical Inhibitors: chemical inhabitation, including demulsifiers or any other production chemical as e.g. biocides, and HCl 15% (related to well intervention), are injected for well integrity requirements and some residuals are available in the produced fluid stream.

ii. Construction Conditions

- Transportation, storing, loading and unloading.
- Pipeline Corridors.
- Construction Loads: refer to clause III.1.5 for more details.

iii. Environmental Conditions

RTP Pipe system shall be designed to withstand safely the most severe anticipated conditions experienced during installation and within the design life of the system.

- Weather;
  - Direct exposure to sunlight has influence on the cost and design life of RTP due to the specification of UV resistance external layer.
  - Heavy rains and water accumulation especially at the low points of the pipeline route, this could causes floating and movement of the aboveground surface laid pipeline. Stable weights, such as sand bags, shall be provided to avoid instable conditions.
  - Sand movement and plastering wind cause sand accumulation on the surface laid flowlines as well as cause anomalies on their surfaces.
  - Current and Waves; Meta-ocean survey report is containing all the information of currents and waves for offshore pipeline installation.
- Terrain;
  - Onshore terrains are varied from sandy, rocky, gatch and Sabkha.
  - Sabkha terrain is changeable based on the change of seasons as underground water height is changing from 1.5m below ground to be on-surface.
  - Offshore terrains are shallow and moderate water.

The flexible composite pipe system shall be designed to withstand the most severe anticipated conditions experienced during installation and within the design life of the system.

The flexible composite pipe system shall be designed to withstand the loads that can potentially be experienced by the pipe system during the anticipated design life.

Manufacturers shall design RTP pipeline to withstanding the above mentioned conditions and to provide for each project a mechanical calculation report addressing the following:

A. Pressure capability

- Reinforcement loading; capacities are achieved through adjusting the number of reinforcement layers, reinforcement mechanical properties and wrap angle.

- Manufacturing process; methods of application and bonding reinforcements affect performance

B. Strain behavior

Desirable strain behavior can be achieved through careful selection and wrap angles by attaining the desired levels of;

- Axial strain
- Hoop strain
- Glass strain

C. Installation parameters

Acceptable ranges for the following parameters are defined for a given design:

- Maximum tensile loading applied to pipe and fittings
- Minimum bend radius
- Temperature range for pipe deployment and joining system installation
- Exterior abrasions and kinks

D. Operation parameters

- Cyclic pressure
- Important to match pipe and fitting designs with applications within acceptable cyclic performance envelope
- UV resistance
- Chemical compatibility with production fluids and acid jobs.
- Heat tracing

E. Permeation

The least of permeation considerations are as per followings, which shall be avoided:

- Gas accumulate in annulus and create a pressure that could collapse the liner.
- Hydrocarbon Gases that permeate through the liner vent to atmosphere.
- Gases that permeate through the liner create an environment that is incompatible with reinforcement materials.
- Gases that exit the pipe due to permeation create an environmental concern.
- Oxygen, from atmosphere, can be permeated into the pipeline and mix with hydrocarbon fluid. The oxygen permeation is not permitted from atmosphere for the safe operation of the flexible pipeline with hydrocarbon.

Accordingly RTP manufacturer shall design RTP to fulfil the following:

a. Gas permeation is common phenomena of plastic / polymers materials and both RTP manufacturer and designer shall limit and / or prevent the permeation to exceed the acceptable limit (<15 ppm H2S at GLC).
b. RTP manufacturer shall provide a gas permeation calculation report of the RTP proposed for each service.
c. RTP for Oil Production Wells with high H2S (>100 ppm) shall be designed to have very low permeation and it shall be buried / backfilled by at least 0.5m stabilized sand. Designer shall, with technical support from RTP manufacturer, provide adequate design of RTP flowline to limit the H2S permeation to be less than 15 ppm during the design life of the project.
d. RTP for Gas Lift oil production with high GOR (> 500) and high H2S shall be featured with non-permeated layers.

F. Collapse

Pipe must be designed to withstand liner collapse due to:

- Internal vacuum
- External pressure
- Pressure in annulus due to permeation

Composite Pipeline data sheet shall at least includes sizes, lengths, maximum operating pressures, minimum & maximum operating temperatures, fluid chemical compositions including types of chemical inhibitors and biocides, design factors, composite material types, dimensions of layers, thermal coefficients, testing and inspections.

Also surface laid RTP pipeline movement within the existing and new corridors shall be controlled by stabilized weights whichever is more practical, reliable and cost optimized.

RTP Pipelines shall be checked against buckling and collapse as result of combined tension and external pressure. 3D model calculation or finite element calculation shall be developed for each type RTP Pipelines to check the maximum external and internal loads and stresses can the pipeline withstand without changing in the wall thickness, mean radius, pre-buckling deformation effect and over-stresses on tie in connections. Both RTP Pipelines vendor and designer shall carry out buckling and collapse calculation during the engineering stage of each project to assure adequacy of the selected RTP Pipelines with service operating conditions.

Buried RTP Pipelines could be carried out either inside trenches with burial depth of 1.0m (Onshore Pipelines Design & Construction Specification AGES-SP-10-003 and

the typical drawings 30-99-22-0006 (AON) or surface laid with 1.0m backfilling berm of dune sand and gatch cap, refer to Fig. 2 and Fig. 3 clause III.3.2.

Very important Note:

Surface laid RTP pipeline with 1.0m backfilling berm construction shall be treated as restrained pipeline design and it shall follow all the requirements of Onshore Pipelines Design & Construction AGES-SP-10-003, Fig.2 and Fig. 3 in clause III.3.2, typical drawings 30-99-22-0006 (AON), project specific design requirements and Manufacturer recommendations.

RTP Pipelines crossing normal sand / semi-gatch tracks (width up to 6m) shall be direct buried and it shall consider the maximum load as the heaviest vehicles and trucks will cross over the RTP pipelines; refer to Onshore Pipelines Design & Construction AGES-SP-10-003. RTP Pipelines manufacturers shall consider the external loads effect on the design and the material selection of the reinforcement layers based on the project requirements.

Designer could also consider sleeve pipes wherever traffic loads is very high, in case of Rig Crossings, and this may cause damages to RTP Pipelines or due to cost optimization of RTP pipelines without compromising the minimum design requirements.

Crossing calculations for Rigs, Tracks and Roads shall be carried out in line with RTP pipe design code considering different loads and stresses, as applicable, in API RP 1102 (Steel Pipelines Crossing Railroads and Highways).

III.1.5 Construction Loads

RTP design shall cater for the construction loads generated during all phases of the pipelines construction including the following:

- Rolling of line pipes
- Pipe transportation loads
- Handling of pipe and pipe sections, e.g. pulling of pipe sections, lowering in trenches … etc.
- Static and dynamic installation loads
- Stability weights
- Pressure testing
- Commissioning activities, e.g. increase in pressure differential due to vacuum drying.
- Dynamic loads from pre-commissioning activities, e.g. flooding and de-watering with pigs.
- Inertia loads due to sudden water filling, excessive deformation in over-bend and sag-bend, and forces due to operation errors or failures in equipment that could cause or aggravate critical conditions shall be considered.

Damage or abnormalities that may affect the safety or reliability of the pipeline on the long term shall either be removed by replacing the damaged section of the pipe or repaired by local reinforcement as per agreed. Alternatively, the pipeline may be permanently re-qualified to lower operational conditions, e.g. reduced pressure, which may remove the requirement for repair. Sharp surface defects like cuts, grooves, gouges, and notches shall be removed or maintained by agreed repair methods.

III.1.6 Fittings for RTP Pipelines

III.1.6.1 Fittings Types and Material Selection

RTP Pipeline sections shall be connected within the pipeline route and tie in to the wellhead and stations piping.

All metallic end connections of RTP flowlines, surface laid or buried, shall be manufactured from solid Inconel 825 or higher for all hydrocarbon and water sour services.

Tie in of RTP Pipeline with wellhead and station piping shall be at the code break point which is the mating flange of isolation valve.

The tie in flange of RTP pipeline shall be ASME B16.5 and shall have same spec and rating of wellhead and station piping.

The selection of fitting type for connecting of RTP pipeline sections shall be based on the following basis:

a) Services; this is including toxic or non-toxic, sour or non-sour, single phase, multiphase and high GOR.

b) Pipeline Construction; surface laid or buried.

c) Fittings Durability and Reliability; non-metallic, carbon steel or CRA material.

d) Operation and Integrity Strategy; permanent or reusable for short time installation (< 5 years) refer to clause III.1.3

Fittings shall be part of RTP pipeline test and inspection qualifications and certificates by manufacturers as per clause III.2 in this specification and API 15S.

The most types of RTP pipeline fittings are:

1) Flanged: which is commonly used for pipeline tie in (terminals) with existing metallic piping system.

2) Hub and Groove metallic connectors: is suitable for specific applications inside stations and single phase liquid services.

3) Metallic Mid Line Coupler: it is suitable for sour service, high GOR oil production and toxic service. Also it is suitable for buried and surface laid installation, however it is not suitable for the reusable concept of the RTP pipelines.

4) Electro Fusion Coupler (GRE): it is suitable for water services. It is suitable for surface laid and buried installation in corrosive soils as a replacement of the

metallic connections and cathodic protection. The design of this type of connection shall be in line with the requirements of API 15S and API 15LE.

The above fittings types and any other invented types shall be qualified as per this specification and API 15S as recommended by manufacturers and designer.

Metallic end joints shall be connected properly with the RTP Pipelines section to assure adequate performance during operation. All types of jointing shall be factory tested and qualified as per requirements in clause III.2 and API 15S.

RTP Pipelines Manufacturers shall provide technical documents, training courses and methods of statement of the joints of fittings to the RTP Pipelines sections and also shall provide jointing machines as part of their delivery as mentioned in clause III.4.1.3

III.1.7 Design Factors

RTP Pipeline shall be designed with specific design factors based on its service, installation methods and location classes. Designer shall pay attention to the different external loads and nature of terrains that RTP Pipeline could be exposed during the design of the pipeline.

Similar to metallic pipelines, RTP Pipeline shall be designed at least as per the following factors:

- Classification Factors shall be 0.72 for normal terrain and 0.6 for crossings, refer to the Onshore Pipelines Design & Construction Specification AGES-SP-10-003.
- Design factor (Non-metallic reinforcement layer RTP) = 0.67
- Design factor (metallic reinforcement layer RTP) = 0.5
- Service factors = 0.67 for gas services (single and multiphase gases).

  = 0.8 for liquid and multiphase hydrocarbon services.

  = 1.0 for water applications
- Hydrotest design factor = 1.3 of nominal pressure for steel reinforcement or for non-metallic reinforcement.

The final Mechanical Calculation Report (MCR) shall be issued by RTP designer for COMPANY review and approval prior commencing manufacturing of the pipeline.

III.1.8 Material Certification

Pipelines shall be Monogramed as per API 15S for all metallic and non-metallic reinforcement layer RTP Pipelines. However API 17J monogram is also accepted as sole monogram for the metallic reinforcement layer RTP Pipelines subject to fulfilling the mandatory and optional requirements as per API 17J and API 15S.

In case of contradiction between this specification, API 15S and API 17J; vendor shall apply the most stringent requirements and clarify the differences in the material data sheets prior the manufacturing phase.

Each layer of RTP Pipeline Composite shall be manufactured, tested and inspected as per this specification, API 15S and applicable ASTM and ISO codes.

Outsourced internal layer of RTP pipeline shall also be manufactured, tested and inspection as per this specification and the applicable ISO or ASTM design standard codes.

Metallic reinforced material and fittings shall be NACE MR01-75 compliance and certified as per BS EN 10204; 3.2.

III.1.9 RTP Vendor Qualification

RTP Pipeline shall be design with specific design factors based on its service, installation methods and location classes. Designer shall pay attention to the different external loads and nature of terrains that RTP Pipeline could be exposed during the design of the pipeline.

Similar to metallic pipelines, RTP Pipeline shall be designed at least as per the following factors:

a. Experiences:
   - Approval letters from end users (upstream companies) including the scope of supply and limitations.
   - Buyers/customers feedback in terms of appreciation/recognition letters, non-conformance report, failure investigation report, customer complaints and lessons learned.

b. Technical experiences in RTP design, metallurgical, manufacturing, inspection and testing:
   - Vendors' Experts shall have at least 20 years' experience in design of non-metallic and flexible pipelines.
   - Products catalogues including sizes, thicknesses, material properties, pressure classes …etc.
   - Technical data sheets including technical description, tests, range of applications, services, limitations, sour services limits, single / multiphase fluids, mechanical specifications… etc.
   - Compliance Certificates and / or reports from international organizations such as API, ISO, NACE, ASTM, DNV indicating the product ranges including sizes, thicknesses, materials, pressures and temperature ratings and services are capable to withstand the same services or higher. It is important to highlight that any compliance certificate or report shall specify details and range of products under specific services and any other products outside this range shall have specific certificate.

- Copies of technical assessment reports issued by vendor experts for the line pipes failures occurred during the line pipe manufacturing process, testing or inspection.
- Copies of failure investigation reports issued by vendor experts for the line pipes failures occurred during the pipeline installation and operation (if any).
- Procedure of Failure Root Cause Analysis and Reporting for the line pipes anomalies during manufacturing process.
- Guidelines for Field tests and inspection methods and procedures.
- Maintenance and repair procedures.
- Samples of guarantee/warranty letters for this kind of products.
- Samples from all test reports and material certificates.

c. Engineering and simulation software.
   - Every vendor shall has a technical office to carry out the engineering of RTP pipelines.
   - Different types of software shall be available to carry out different types of simulations such as thermal expansion, strain, fatigue stress, bending stress … etc.

d. Full testing and inspection facilities to fulfil the requirements of API SPECS 15S and 17J monograms and certificates.
   - Testing and Inspection manuals, methodologies and procedures pipeline.
   - List of NDT inspection tools (manual and automatic) specialized in RTP materials with their technical data.
   - Certificates and Inspection reports (latest 3 reports) of the testing and inspection facilities.
   - Copies of BS EN 10204 material certificates from previous orders.
   - Copies of tests and inspection reports from old delivered pipes.
   - Details of Product Lab tests reports (for Gas & Liquid Sour Hydrocarbon) approved from ISO 17025 accredited labs with demonstrable experience in the testing and characterization of non-metallic materials.

e. Packing and protective coating facilities.
   - Packing and coating facilities shall be within or close to the manufacturing facilities to minimize the transportation time and quality issues may occur during the mobilization and demobilization of line pipes.
   - Procedures of packing and coating processes shall be reviewed in details to ensure the adequate protection of pipeline.

- Packing and coating materials shall be reviewed with their technical data sheets, made, shelf life … etc.

III.1.10 Operation and Integrity

Based on pipelines services and project requirements, RTP Pipelines manufacturers shall establish operation and inspection philosophy for each project and for each type of RTP Pipeline showing the following details:

1) Pipeline Services
2) Maximum and Minimum Operating pressures and temperatures' Conditions.
3) Fluid Compositions.
4) Different Modes of Operations Filling, pressurization, depressurization, shutdown …etc.
5) Upper and Lower Limits of reservoir conditions (i.e. H2S, CO2 …etc.) in which RTP Pipelines shall be out-of-service.

RTP Pipelines are categorized as composite non-metallic material because of the design of internal and external layers; the integrity and fitness for service conditions of RTP are practically unknown as the tools and technologies of field inspection are still pre-matured. It is recommended to install two test spools with end flanges of RTP pipe with average length of 1.5 to 2.0 Mt at locations where the severe operating conditions of the services are present; i.e. near to wellhead piping, pumps …etc.

RTP Pipelines manufacturers shall provide Inspection and Integrity manuals showing the possible tests and inspection that shall be carried out on the pipelines and test spool including frequencies and authorized labs during the life time of the pipelines.

RTP Pipelines may be exposed to different uncontrolled external or internal conditions which can influence the pipelines performance and cause loss of containments. RTP Pipelines Manufacturers shall provide maintenance manual of each type including the composite repair kits recommended per each type of RTP.

III.2 AMENDMENTS AND SUPPLEMENTS TO API SPEC 15S

- Clause 4,
  - 4.1 add: " design, selection and supply …"
  - 4.2.1.1 delete " Fusion joints in the liner …." Whole sentence.
  - 4.2.1.1 modify "Changes to the liner may require requalification in according to modified clause 5.6".
  - 4.2.1.2 modify "As a minimum, polymer aging estimates shall consider temperature, chemical reaction with oxidizations & biocides, water cut, and pH".
  - 4.2.2.1 modify "Joints or welds in the reinforcement shall be limited to the end of pipeline batch and it shall be made according to a qualified procedure by a qualified operator".

- 4.2.3 change first sentence " …. manufacturer specified service conditions" to be " … COMPANY specified service fluids and field conditions".
- 4.2.3 add & modify the 2nd paragraph " …. installation methods, environmental conditions and operating …"
- 4.2.3 add at the end of 2nd paragraph " … examples include solar radiation (UV) and wear resistance and corrosive soil resistance".
- 4.2.4.1 change the 1st sentence "… in accordance with either a written specification or an applicable industry standard." to be " in accordance with COMPANY material philosophy and project material selection report" and replace "the manufacturer specified service conditions" with "COMPANY specified fluid chemical compositions and maximum operating conditions".

- Clause 5, it shall be read as Material Qualification Program as it is only for flexible pipeline and Fittings material manufacture, inspection, testing and supplying.
  - Clause 5.1 replace the 2nd and 3rd paragraphs with the following:

    Liner Intermediate joints in the batch are not permitted to avoid weak points and integrity issues of the pipeline. In special project cases such as batch design longer than manufacturer standard and with technical approval from the COMPANY, butt welds fusion joint can be allowed with proper qualification and testing procedures different from the normal RTP qualification and testing procedures.
  - Clause 5.2.3.1 at the last sentence; read MAOT as Maximum Allowable Operating Temperature of the application.
  - Clause 5.6

  - In the 2nd paragraph delete word "cover"
  - In the 2nd paragraph modify "… comply with the standards …" to be " … certified and / or monogramed to the standards …".
  - In the 2nd paragraph delete complete sentence "For thermoplastic materials where no industry …".
  - In the 4th paragraph change to "Changes to the liner or cover as described in Table 3 shall also require recalculation of permeation, reengineering in accordance with service fluid application, accelerated life testing of the end-connection system in accordance with 5.4.3, 5.4.4 & 5.4.5 as minimum."
  - In the 4th paragraph modify "… in accordance with."
  - Table 3 read as per following modifications:

1.1.1.Liner/Cover	Any change in the qualified polymer compound except by replacement with the same compound from a different vendor. A design change in higher thickness of liner or cover. Compounds not part of the PFR qualification process shall also be tested in accordance with 5.7, unless

	specifically exempt by the technical justification. All compounds shall be qualified in accordance with Section 4. Any Acceptable Change shall also be tested in accordance with 5.4.3, and, unless specifically exempt by the technical justification, with other tests from 5.4 and 5.5.
1.1.2.Reinforcement	Material supplier; certified from ISO and / or ASTM Supplier's grade and specification Filament diameter 1.1.3. Tow size/configuration
Reinforcement Matrix and Adhesives	Material supplier; certified Higher Grade, superior material Thermoset curing system manufacturer Thermoset curing system grade 1.1.4. Thermoset Tg
1.1.5.Manufacturing	Transfer of manufacture from one plant to another had the same qualification certificate or additional qualified manufacturing lines or locations (qualified by COMPANY and monogramed by API 15S) 1.1.6. Transfer from prototype to equivalent commercial production manufacturing technically approved by COMPANY and monogramed by API 15S.

- Clause 5.7; all the tests under this clause and sub-clauses are mandatory to be implemented by manufacturers.
- Clause 5.7.2; modify 2nd paragraph as per the following:

  “the UV resistance of other cover material for transportation, storage and surface installation shall be tested and simulated through accelerated weathering damaging effects of long term outdoor exposure tests as per standards ASTM G154, ASTM D4329 and / or BS EN ISO 4892 parts 1, 2 & 3”.
- Clause 5.7.4 add new paragraph as 1st paragraph “Thermal expansion test shall be carried out as per ASTM E831, ASTM D696 and / or BS ISO 11359”.
- Clause 5.7.5 modify as the following “The manufacturer shall measure and quote changes in pipe length and diameter in accordance with ASTM D2122 to measure changes which takes ….”
- Add new Clause 5.7.6 “Permeation Test” with the following write up:

  The Manufacturer shall provide coefficients for permeability, diffusivity and solubility for the services as mentioned of project design basis provided by the COMPANY and the test shall be carried out as per ASTM D2684 / D2684M-15 and / or EN 14125 for determining the permeation.

- Clause 5.8

- Modify 1st sentence to be “A qualification test with pass/fail criteria shall be subject to this retest procedure.”
- Re-read the 2nd paragraph as per the following modification “If one or more of the original test specimens fail to conform to any of the specified requirements for a particular test, the manufacturer shall repeat the test again after officially informing COMPANY representative and getting written approval on re-testing procedure. For each original non-conforming specimen, two additional replicate specimens shall to be made from the same batch and tested under the same tests conditions. If all the retest specimens conform to all specified test requirements, the retesting is successful and the original test requirements are met. In case the tests are failed; the batch shall be removed from the shipment and another two specimens from another batch, randomly selected by COMPANY representative, shall be re-tested again as per the approved re-test procedure. All re-tests shall on hold and to be conducted in presence of COMPANY Representative”.

- Clause 6,

  - Clause 6.1 Quality Management System; add “… in accordance with QMS 30-99-97-0006 (AON) no , API Q1, ISO TS 29001, or ISO 9001”.
  - Clause 6.2 modify as “The liner internal and external surfaces shall be free of holes and other defects that could influence liner integrity, cause mechanical damage, degradation of material, influence design life, decrease liner dimensions, increase permeation , cause a leak or prevent containment of the intended fluids.”.
  - Clause 6.2 add new paragraph “For the internal defects such as bubbles and cracks which could be formed in liner cross sections during the extrusion; manufacturers shall select three specimens (each specimen length is 1 meter) from the first 50 m of the liner and cut out from each specimen 5 samples longitudinally and 5 samples circumferentially for microscopic inspection. The liner material shall be free from all types of defects and internal. The selection of specimens, samples and microscopic inspection method and results shall be reviewed and approved by COMPANY”.
  - Clause 6.4.2.1 modify the 2nd paragraph as the following:

    Two tests shall be provided for batch pressure testing: (1) the short-term burst test and (2) the constant pressure test.

    Reusable end-fittings, different in design to those used in the field, shall not be employed for these tests. Only the end fittings similar design to the used in the field shall be utilized.

  - Clause 6.4.2.4 add the following “… but the manufacturer may after written approval from COMPANY elect to make retests …”

- Clause 6.4.2.4 add the following at the end of the 1st sentence "… replicate samples from the same batch from the same locations."

III.3 RTP PIPELINE CONSTRUCTION

III.3.1 General Requirements

CONTRACTOR shall use competent personnel at all stages of the project. Permanent technical, managerial and planning personnel shall have adequate education, training and experience commensurate with their duties and level of supervision under which the work is performed. These requirements shall be part of the CONTRACTOR's quality management system.

The installation CONTRACTOR shall demonstrate compliance with QA/QC system.

RTP manufacturers provide installation method statement and manual that should be followed to successfully construction. Normally the manufacturer's representative shall be required to provide a field service supervision and train the installation crew in proper handling, joining, and installation techniques.

In case of any suspected damage on the pipe be evident, a manufacturer's representative can provide pipe inspection and assessment assistance. The representative's services should also be utilized during installation pre-bidding meetings (pre-inspection meeting "PIM"), installation planning meetings, and onsite during field construction.

RTP Pipeline construction is requiring specially qualified, trained personnel for installation, testing, pre-commissioning and commissioning activities.

All engineering analysis and calculations required to support installation procedures shall be performed by technical staff with the appropriate qualifications and experience. Such work shall be discipline checked and approved by responsible engineers in the CONTRACTOR's organization or external consultants.

CONTRACTOR shall assure RTP flowlines and pipelines stabilities during construction, hydrotesting and different operating modes to avoid affecting the RTP flowlines and pipelines integrity as well as impacting the operation of adjacent flowlines. Based on manufacturers' recommendations; stability weight blocks, sand bags or other means shall be provided and the RTP pipes mechanical design shall consider their loads.

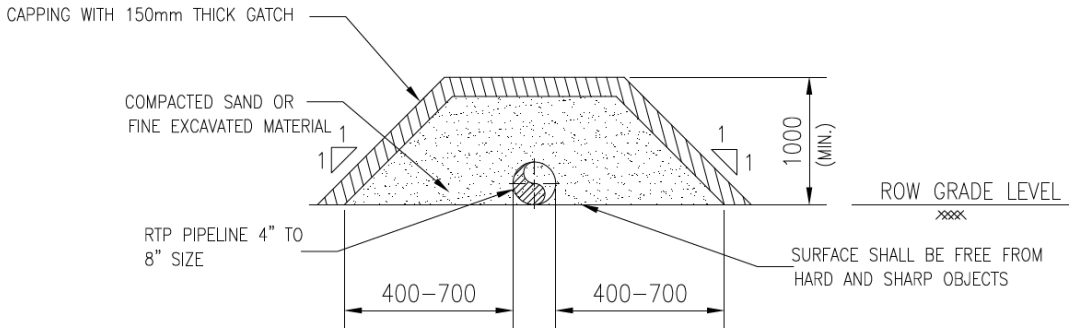
III.3.2 Pipeline Installation

RTP Flowlines construction is either by surface laid or buried in accordance with Onshore Pipelines Design & Construction Specification AGES-SP-10-003.

Lifting and lowering of the pipeline sections shall be analysed to determine the critical parameters and operational criteria for the operation. Critical parameters/operational criteria shall be monitored continuously.

In case of buried RTP Pipelines; construction should follow Onshore Pipelines Design & Construction Specification AGES-SP-10-003 with the following modifications:

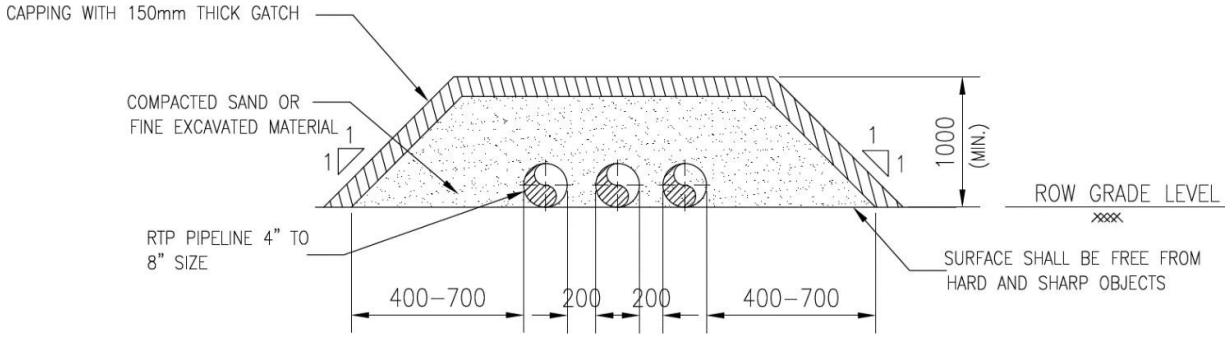
1) Pipelines can be installed on surface with buried concept by providing berm construction as per Fig. 2. This design will provide stabilization, UV protection and restrain to the pipeline. Upon project specification and type of service, the surface laid with berm will provide long design life of the pipeline for at least 30 years and provide low cost of the material as UV layer will not be required.



BURIED TYPE FOR SINGLE PIPELINE

Fig. 2 RTP Surface Laid Pipeline With Berm

2) In case of tied corridors or replacement of corroded pipelines, multiple pipelines can be also surface laid by providing the berm construction as per Fig 2. The benefits will be as mentioned in point 1 above.



BURIED TYPE FOR MULTIPLE PIPELINES

Fig. 3 RTP Surface Laid Pipelines With Common Berm

- In points 1 & 2, Designer shall calculate the minimum backfilling requirements to achieve the stability of the pipelines against lateral and upheaval buckling during the life time of the RTP Pipelines.

3) All the pipeline markers shall be specifically marked with “Reinforced Thermoplastic Pipeline”.

RTP Pipeline vendors shall be responsible for the Markers installation for both surface laid and buried pipelines to avoid any physical damages may occurred to the pipelines.

4) RTP Pipeline Approach to manifold station shall be studied as per HAZID and Constructability studies as well as conditions of the field.

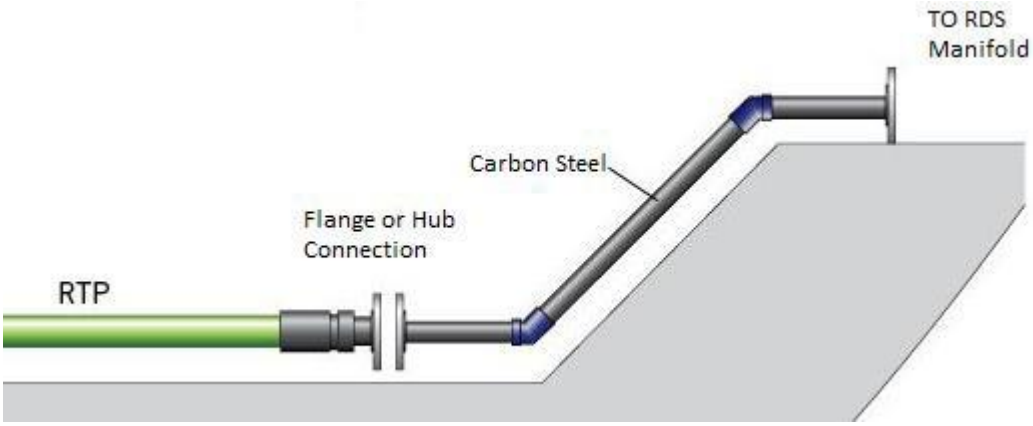


Fig. 4 – RTP Approach Connectivity (Outside the Fence)

- All other construction requirements shall follow Onshore Pipelines Design & Construction Specification AGES-SP-10-003 in addition to manufacturers' recommendations.

III.3.3 Crossings

III.3.3.1 Asphalt Roads, Plant Roads and Field Roads

Crossing beneath field asphalt roads shall be Trenchless (Horizontal Directional Drilling – HDD) carried out by Specialist CONTRACTOR. Crossing Design shall consider additional loads generated on the pipeline from HDD process. Designer may require increasing the wall thicknesses of the RTP pipes but with constant Inner Diameter after consulting RTP pipeline manufacturers.

Crossing existing Rig roads shall be carried out in metallic sleeve pipes considering the maximum rig loads available in each field.

Sleeves could be filled with soft sands and provided with isolated end caps or inserted foam to prevent the loosing of the soft sands. Also, spacers can be used to centralize the pipe in the sleeves.

Non-metallic sleeves buoyancy shall be considered in the high water table soil as per the project geotechnical reports.

Only brand new crossing sleeves pipes shall be provided with adequate wall thickness in case of non-metallic sleeves; Designer shall include the sleeve wall thickness calculation as part of engineering documentation.

Metallic sleeve can be utilized subject to the following conditions:

a) Pipes material types and grades shall be known and pipes shall be in good conditions.

b) Pipes wall thickness adequate to sustain mechanical loads, shall be at least 5.0mm subject to design requirements.

c) Sleeve Pipe shall be supplied in double random lengths and its internal and external surfaces shall be free from anomalies such as dents, gouges, notches and any sharp edges.

d) In case of roads crossing width more than 12m (such as Rig Roads).

e) Steel sleeves shall be externally protected with proper coating and sacrificial anodes. For details refer to standard specification AGES-SP-07-001.

III.3.3.2 Existing pipelines, Piping and Cables

- RTP pipelines shall cross below the existing pipelines, piping and cables with minimum separation distances as per COMPANY typical crossing details 30-99-22-0006.
- Identification slabs (RCC) shall be provided to all types crossings and designed as per COMPANY typical drawings 30-99-22-0006 (AON).
- Crossing 3rd parties existing facilities shall be in according to their design and approved Non Objective Certificate (NOC).
- Deep crossings due to low burial depth of existing facilities can be implemented either by HDD or in sleeve whichever suitable as per site conditions.

III.3.4 Row and Pipelines Corridor

The pipeline shall be located at the center of the ROW, unless indicated otherwise. CONTRACTOR shall co-ordinate with all local Authorities and utility owners to obtain the approval for the ROW.

Prior to the commencement of any construction activities in an area, the CONTRACTOR shall locate and identify all existing buried facilities, such as cables, pipelines, piping, water mains, sewers, ...etc., including those not shown on the drawings, crossed or at close proximity with the pipeline, by contact with relevant Authorities, carrying out appropriate surveys and exposing them by hand excavation, unless exempted in writing by the CONTRACTOR and shall be clearly marked.

CONTRACTOR shall submit for approval a detailed proposal for precautions to be taken for avoiding or preventing damage to existing facilities above or below ground. The CONTRACTOR shall not be entitled to extra compensation for any hardship and/or increased costs caused by the construction areas being adjacent to or in sand dunes or other difficult terrain or across roads, berms, flooded areas, communication structures, wires, cables, other pipelines, power poles, plantations, farms or other obstacles, which may physically restrict or limit the use of the ROW provided.

III.3.4.1 Row in Rough and Rocky Terrain

ROW in rough and rocky terrain that occurs at certain locations shall be prepared by CONTRACTOR, with the use of special equipment as necessary. Wherever rocky terrain is encountered, grading and excavation to prepare ROW shall be carried out by

ripping, drilling, wedging, chiselling using jack hammers or rock breakers, or by other recognized approved methods. Blasting will not be allowed.

III.3.4.2 Row in Sand Dune and Sandy Areas

The ROW in sand dune and sandy areas shall be graded by the CONTRACTOR in compliance with the relevant drawings and shall be approved by the COMPANY. The profile of the graded ROW shall generally follow the profile of the natural terrain with some minor alterations to enable proper construction of the pipeline and ensure safe bending and laying of the pipeline. While grading, any necessary cutting of high dunes shall be performed. The cut material shall be generally spread on the sides of the ROW and filling of low areas shall be minimized.

Trenching will follow the general profile of the ROW as per the cover requirements. Localized sand dunes along the pipeline alignment shall be removed by CONTRACTOR as a part of his scope of work while preparing ROW.

RTP Pipelines shall be constructed with a Right of Way (ROW) as per the requirements in COMPANY Specification for the Onshore Pipelines Design & Construction Specification AGES-SP-10-003 based on project requirements.

Pipeline markers shall be provided to RTP Pipelines as per project requirements and Onshore Pipelines Design & Construction Specification AGES-SP-10-003.

III.3.4.3 Row in Sabkha Area

The ROW in Sabkha areas shall be constructed with gatch material, which shall be consolidated by compaction. The type of fill material to be used by CONTRACTOR shall be approved by the COMPANY and as per the specification of Pipeline Bund, Berm, Anchor Blocks and ROW Construction No. AGES-SP-01-017.

RTP Pipeline construction in Sabkha, refer to Fig. 5, RTP Pipeline installation shall be as per the following basis:

A) Hurdle Construction

- RTP Pipelines and other carbon steel flowlines can be installed on common hurdles keeping 500mm (min.) standard spaces and providing L beams as movement stoppers between the pipelines.
- Hurdles material pipe sizes and thicknesses shall be as per their availability at site (4in or 6in) and designer shall calculate the hurdle final dimensions on that basis.
- Intervals between hurdles shall be calculated based on the minimum requirements as recommended by designer and RTP pipeline manufacturers.
- Hurdles shall be installed above levelled subgrade material with height of 300mm and hurdles minimum height shall not be less than 400mm and shall not exceed 700mm to justify the flowlines elevations unless project specify otherwise.

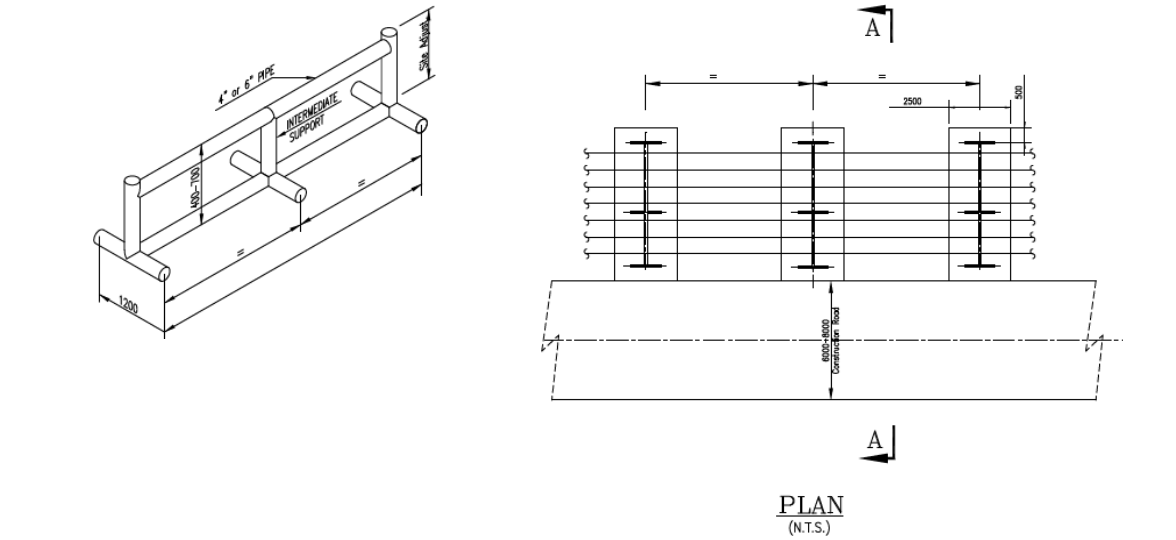


Fig. 5 – RTP Pipelines in Sabkha Terrain – Aboveground

B) Berm Construction

- RTP Pipelines in Sabkha berm construction is applicable in areas whenever buried installation is being considered as per project requirements.
- The optimized design as shown in Fig. 6 can be utilized for single and multiple pipelines construction with adequate modification in the dimensions.
- The design is considered as alternative design option of surface laid flowlines as shown in Onshore Pipelines Design & Construction Specification AGES-SP-10-003.
- RTP Pipeline shall be partially buried in the gatch layer (1/3 to 50% of pipe diameter), the pipe shall be surrounded in bedding and embankment with at least 150mm soft (Dune) sand layer.
- Backfilling with soft (Dune) sand up to 1.0m with gatch cap layer 150mm (minimum) thickness shall be provided above the pipeline. This height shall be confirmed and optimized by designer / RTP manufacturers per each project.
- Right of Way (ROW) with 6m to 8m width – Construction Road shall be provided on either sides of the pipeline based on the site conditions and accessibility to the pipeline during construction and operation.

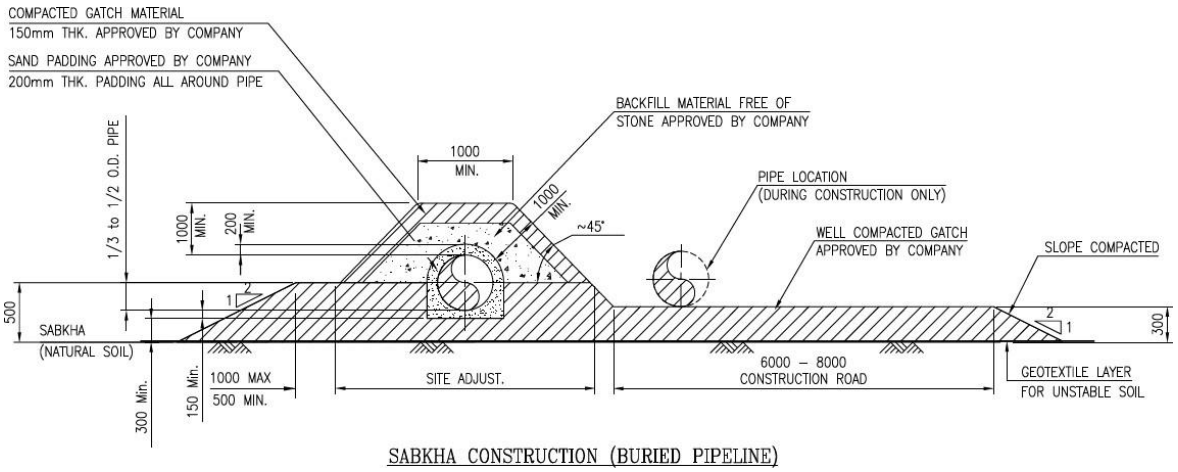


Fig. 6 – RTP Pipeline in Sabkha Terrain – Buried Case

Direct burying of RTP Pipeline in Sabkha terrain shall consider the following:

1) Proper selection of external layer to withstanding the external environment.
2) Stability of the pipeline against buoyancy and buckling effect by stabilization blocks with proper intervals

III.3.4.4 Gatch Material for Row

Gatch material to be used for preparing ROW, or for stabilization shall be of granular dry soil material with high level of cementation content, such as gypsum or clay which when watered, mixed and compacted, gives a firm and solid mass of material. The compacted gatch shall not contain loose patches of soil and shall not break nor erode during normal use and environmental conditions.

CONTRACTOR shall arrange to locate the source of gatch material and obtain the COMPANY approval for the use of the gatch material. Gatch, at the optimum moisture content, placed in the ROW, shall be consolidated by compaction. The gatch material shall be wetted, rammed and compacted.

Selection of the gatch material and the required compaction shall be as per the specification Pipeline Bund, Berm, Anchor Blocks and ROW Construction No. AGES-SP-01-017.

III.3.4.5 Preparation of Row

During the preparation of the ROW, the CONTRACTOR shall grade the ROW to provide access to the pipeline during construction. CONTRACTOR shall grade the ROW to remove sharp objects, to minimize bending and to maximize laying within the limits permissible for elastic bending. Where the construction ROW passes through or along roads, tracks, pole lines, plantations or any other improved or confined areas,

CONTRACTOR shall grade only the width of the ROW necessary for installation of the pipeline.

CONTRACTOR shall establish Benchmark Sand Intersection/Turning Points until the construction is completed. Contactor shall carry out all survey and levelling of line and grades including as-built survey necessary to complete the work and shall be responsible for the accuracy of such survey and grades. The ROW for all the pipelines shall be staked by the Contactor so as to be able to define ROW boundary for purposes of clearing, grading and backfilling and shall be maintained throughout construction.

CONTACTOR shall install distinct markers locating and indicating special points, such as but not limited to contract limits, warning notices, presence of buried structures, obstacle crossings, change of wall thickness including corresponding chainage, … etc.

CONTRACTOR shall have to grade sand dunes to allow vehicle access, safe laying of the pipeline within its elastic limit, and excavation of rock wherever encountered. Fill material shall be installed on the ROW as needed for vehicle access and make necessary arrangements such as ramps, temporary bridges ...etc.

Vibratory compaction of backfill can cause RTP Pipeline to shift or damage its connectivity; therefore appropriate measures and monitoring during installation are necessary. Normally, visual inspections are adequate to confirm the installation is acceptable. However, a mandrel test may be requested by the COMPANY when it is necessary to confirm the acceptability of the construction method statements and procedures.

III.3.4.6 Field Hydrostatic Test

Field Hydrotesting of RTP pipelines shall be carried out by specialist CONTRACTORs, under supervision of RTP vendor specialist, as per the approved hydrotest procedure and guidelines from RTP vendors. Hydrotest calculations shall be carried out by RTP vendors taking into consideration the following factors:

1- Pipeline Profile has variant elevations which shall be considered as static head.

2- Number of pipeline sections shall be minimum to avoid flange connections in middle of the desert.

3- The minimum pipeline section length for Hydrotest and the sequences of hydrotest for each pipeline section.

4- Construction loads and hydrotest factors as per clauses III.1.6 and III.1.8.

Hydrostatic testing of fabricated assemblies shall also be performed at or adjacent to the final location taking into consideration the accessibility and the back pressure from static head.

CONTRACTOR shall carry out hydrotesting calculation for each RTP pipeline as per API 15S requirements and as recommended by RTP vendor. Hydrotest calculation report shall include the calculation sheet, pipeline profile, location of air vents, specification of testing equipment and hydrotest water specification and analysis. Hydrotest calculation shall be endorsed by RTP vendor prior COMPANY review and approval.

III.3.4.7 Tie In

The position of the tie-in shall be verified prior to start of operations. A survey shall be performed to establish that the location is free of obstructions and that the site conditions will permit the tie-in to be performed as specified.

The alignment and position of the tie-in ends shall be within the specified tolerances before completing the tie-in.

Installation of mechanical connectors shall be performed in accordance with the manufacturer's procedure. For flanged connections hydraulic bolt tension equipment shall be used. During all handling, lifting and lowering into the final position, open flange faces shall be protected against mechanical damage.

A local leak test to an internal pressure not less than the local incidental pressure should be performed for all mechanical connections after make-up. This local leak test is additional to the normal system pressure test

After completion of the tie-in, a survey of the pipeline on both sides of the tie-in, and over a length sufficient to ensure that no damage has occurred, should be performed

It shall be verified that the position of the tie-in is within the target area. The pipeline stability shall be ensured and adequate protection of pipeline provided.

III.4 HANDLING, TRANSPORTATION AND DOCUMENTATION

III.4.1 Handling and Transportation

III.4.1.1 Pipe Material Handling and Storage

RTP Pipelines shall be supplied on reels with lengths from 200m up to 600m based on the pipeline size and design. Lengths may vary from vendor to another. CONTRACTOR shall supply pipe materials as specified in the relevant Project Material Specifications and Vendor data sheets at designated areas, subject to the COMPANY approval. Prior to taking delivery from supplier (manufacturer), CONTRACTOR shall examine the pipes which shall satisfy the acceptance criteria for the condition of the pipe. After taking delivery of the pipes, CONTRACTOR shall be responsible for their care and custody and for any repairs to any damage. Transportation of pipe to the construction site is the CONTRACTOR's responsibility.

CONTRACTOR shall follow RTP Pipeline manufacturers' recommendations for transportation, handling and storage including all the precautions to avoid physical damages prior installation.

Any defective pipes shall be rectified or rejected as directed by the CONTRACTOR with official notification to COMPANY; the CONTRACTOR shall supply new pipes as per applicable specification. CONTRACTOR shall be fully responsible for arranging and preparation of storage areas and method of storage shall be as approved the COMPANY.

The CONTRACTOR shall be responsible for handling, hauling, stockpiling, storage and stringing the pipe materials.

Rope, chains with hooks or web slings shall be used with mechanical lifting equipment for reel loading and unloading. Pipes shall generally be preserved and protected against mechanical damages and environments impact during transportation and storage.

For long period storage; RTP Coils / Pipe Reels shall be stored in a secure and sheltered place and such material shall not be strung on the ROW but shall be transported along the line in covered conveyances for use when needed. Coils shall be stored on a flat even surface able to withstand the weight of Coils and lifting equipment. Different sizes of RTP pipes should be clearly marked with their specs and service. All supports shall be free from sharp edges. RTP coils and fittings material shall be stored under cover and rested on wooden pallets or as recommended by manufacturers.

III.4.1.2 UV Protection and Weathering

All silos of coiled pipelines, whether provided with UV protection layer or not, shall be shrink-wrapped in UV-blocking plastic cover. The plastic cover shall be thick enough to prevent accidental tearing and passages of UV .The UV-blocking plastic wrap shall filter out 100% of the UV radiation from reaching any portion of the pipe. If the wrap is damage before or upon arrival on site, the packaged pipes and / or coils shall be immediately rejected as this will cause aging of the pipe surface. Any pipes stored/stacked at site shall be covered by tarpaulin. Storage in containers is not recommended.

A certificate from RTP Pipeline manufacturers shall be provided, confirming that the products may be stored in the open for minimum of 2 years with temporary protective coating without any adverse effect.

III.4.1.3 Marking and Packing

The marking information and sequence shall comply with API 15S, ASTM / ISO standards and this specification. All pipes and fittings, including Inspection spools shall be clearly and permanently marked using indent printing in a colour that contrasts with the pipe or a laser marking system. All RTP Pipelines shall be indelibly marked at maximum interval of 6 – 8 Mt and shall be displayed on the outside of the length together with the other information as listed here after for pipes and fittings.

Pipes shall be marked with information at least and not limited to the followings:

- Production information, e.g. 251Y, where 2 indicates shift, 5 indicates operator, 1 indicates extruder, and Y indicates compound supplier.
- Batch number.
- Client “ADNOC OPCOs”.
- Service Fluid such as Produced Water (PW), Disposal Water (DW), Produced Oil (PO).
- The dimensions (nominal outside diameter x nominal internal diameter in mm).

- Pipe Composite material information (external, reinforcement and internal layers).
- Material of Internal Layer with its designation and grade.
- UV protection of external layer (Y/N)
- Coil Length.
- Nominal pressure (PN) in bar and Temperature in OC / Deg. C.
- Fittings material and type.

The maximum quantity of pipe to have the same coil/length number is one silo (coiled pipe). The maximum combined length of pipe in the silo or bundle with the same coil/length number shall not exceed the maximum allowable coil length specified in the applicable standard or this specification or the purchase order.

When pipe material is boxed, the batch number shall be clearly marked on the outside edge of the box or silo. Packing lists shall include the date of manufacture and coil/length numbers for all material in the shipment.

The fittings shall be packaged in bulk or individually protected were necessary in order to prevent rusting, mechanical damages, deterioration and contamination. The package shall have at least one label with manufacturer name, type and dimension of the fittings, number of units and the batch number.

All the jointing equipment and devices shall be provided by RTP Pipelines Manufacturers along with each shipment with clear methods statements and manuals. EPC CONTRACTOR shall obtain training courses with certificates from RTP Pipeline Manufacturer for handling, laying, jointing, test, inspection and repairing of RTP Pipelines.

III.4.1.4 Vendor Documentation

The Vendor/CONTRACTOR shall furnish the following vendor data as a minimum, with the bid:

- API 15S Monograms.
- Manufacturer pre-qualification documents.
- Quality Management system Certificate.
- Type Tests Certificate for Pipelines and Fittings full “Third Party Type Tests Certificate”.
- Catalogues/ Brochures.
- Dimensional details of RTP Pipelines and fittings.
- Detailed material specifications.
- Evidence for raw material of each layer Association.
- Manufacturer's technical data sheets and drawings.
- Maintenance and Operation manuals.
- Inspection and Repairing methods.

- Complete details of testing facilities at manufacturer works.
- Local (UAE) agent name and address.
- Provisions (certificates/reports) that all materials are Non Toxic.
- Technical Data Sheet.
- Compliance Statement to COMPANY specifications.
- Any other Certificate required as per Standard.

Bids not accompanied by any of above mentioned information/data shall be considered incomplete, and liable to be rejected.

IV APPENDICES

IV.1 APPENDIX-A: MANUFACTURE PROCESS QUALIFICATION TEST

IV.1.1 General

A quality plan and flow diagram shall be produced, showing all the proposed tests and inspections during component fabrication.

Raw material certificates shall be reviewed and accepted by COMPANY prior to the start of manufacture.

Determine the fibre content (mass percentage) as per ISO 1172 of the reinforced wall at a frequency of 1 % continuous production.

The fibre content (mass fraction) shall be within +/- 5% of the mean value quoted by Manufacturer. If the fibre content is not within +/- 5% of the mean value quoted by Manufacturer, then the previously produced components, up to the last successful test sample shall be rejected.

IV.2 Destructive and Non-Destructive Tests

IV.2.1 General

All mechanical tests shall be performed after simulation of reeling and unreeling sequences with considering the minimum reeling radius (inner diameter of the spool).

Raw materials deliveries shall be accompanied with certificates and conformance analysis report.

Incoming batches of raw materials shall be submitted to manufacturer's quality control before being released and used in the pipe production line. Testing of each batch of raw material shall be performed as per ISO 4437.

Fibers deliveries shall be accompanied with certificates and conformance analysis report.

Either tape (width and thickness) or fibers (dimensions) shall be checked.

One tensile test shall be performed on each batch of fibers or fibers tapes to check consistency of maximum axial loading and rupture elongation capacity with conformance certificate.

IV.2.2 Micrography Examination

Micrography examination shall be performed on four specimens on the outer, inner and non-metallic reinforcement layers (12, 3, 6 & 9 O'clock) at each pipe ends to check the good dispersion of additives. The carbon black dispersion shall be less than 3 with quotation of IV.1, IV.2, IV.3 or IV.5 according to EN 1555-1.

IV.2.3 100 Hours Pressure Tests

Four pressure tests shall be performed at Trc ≥ Tdesign at the pressure of the lower confidence limit (at 97.5%) for 100 hours survival. Time to failure shall be strictly above 100 hours and shall be recorded.

IV.2.4 Axial Loading Tests Capacity

Two full-scale axial loading tests shall be performed on the pipe at room temperature and at Trc ≥ Tdesign. Axial loading capacities shall be recorded.

IV.2.5 Compression Ring Test

The pipe shall be completely squeezed between 3 to 9 O'clock positions at exactly the same location. No surface cracks shall be observed.

IV.2.6 Cover Blow Test

A test with increasing pressure in the annulus between the inner layer and the reinforced layer shall be performed .this test shall be performed in a water bath at Trc ≥ Tdesign. The test set-up and testing procedure shall be communicated to the COMPANY for review and approval during the bid stage. No disbanding between the fibers of the reinforced layer and the liner shall be observed.

IV.2.7 Torsion Test

A torsion test shall be performed at Trc ≥ Tdesign to check pipe torsion when applying internal pressure. The test set-up and testing procedure shall be communicated to the COMPANY for review and approval during the bid stage. Internal pressure shall be set to 1.5 times the design pressure. Torsion angle shall be <5o per meter and tube elongation shall be < 0.4%.

IV.2.8 Weldability Test

A weldability test shall be required if field welding is not performed under responsibility of the pipe manufacturer. In this case, a full welding qualification as detailed in welding qualification shall be performed.

IV.2.9 Fatigue

If required by the COMPANY in the pipeline datasheet; then fatigue tests shall be performed at Trc ≥ Tdesign with varying internal pressure. Pressure variations (ΔP) and test frequency shall be determined in pipeline datasheet.

IV.3 Inspection and Testing

IV.3.1 Visual Inspection

Internal and external surface shall be free from scoring, cavities and all other types of surface defects. Pipe ends shall be square cut to the pipe axis and clean.

A visual inspection shall be performed on 100% of the pipes, external surface shall be free from scoring, cavities and all other types of surface defects. Internal surface shall be flushed with inert gas to remove all pollutions. Pipe ends shall be square cut to the pipe axis and clean.

IV.3.2 Dimensions Check

All dimensions shall be compared with the dimensions in the pipeline; all out-of-tolerance components shall be rejected.

The following dimensions for at least 1 % of continuous production as per ASTM D3567:

a) Internal diameter
b) Outside diameter
c) Mass
d) Liner thickness
e) Minimum liner thickness
f) Reinforced wall thickness

The inside diameters of the pipes shall have a precise dimension, while the COMPANY reserves the right to check this dimension.

Out of roundness shall be measured and recorded on both pipe ends and all pipes at 4 points (12, 3, 6, 9 O'clock).The variation of wall thickness among the pipes of the same order shall not exceed +/- 5%.

The first eight finished pipes or the first reel produced in each size (each diameter and each wall thickness) and grade shall be subject to the inspections and tests as described hereafter in order to proceed the qualification of pipe manufacturing procedure.

IV.3.3 Inspection Essential Variables

- Any change in pipe outside diameter and wall thickness
- Any change in raw materials (type, supplier, purchase specification)
- Any change in extrusion equipment :screw diameter, total machine length,..,etc
- Any change in wrapping angle of the reinforced layer of more than +/- 1^{O}
- Any change in pigments and additive contents of more than +/- 5%
- Any variation in haul-off speed more than +/- 0.5%
- Any variation in processing temperature(s) more than +/- 10 ^{O}C
- Any variation of extruder output rate of more than +/- 2Kg/Hr

- Any change in cooling equipment (one side or two sides cooling, type of gas used for cooling … etc.).

IV.4 Fittings Test and Inspection

IV.4.1 Dimensional Inspection

The following dimensions of the fittings shall be measured and recorded:

- Length.
- Outer diameter, thickness and length cover.

IV.4.2 Radiography Inspection

Electrofusion pipe fittings have to be 100% radiographed .the right positioning of heating elements shall be checked. Any fitting showing heating elements not rightly positioned shall be rejected.

IV.4.3 Mill Certificate

Inspection certificates shall be 3.2 certificates as per EN10204.

Mill certificate shall show the following:

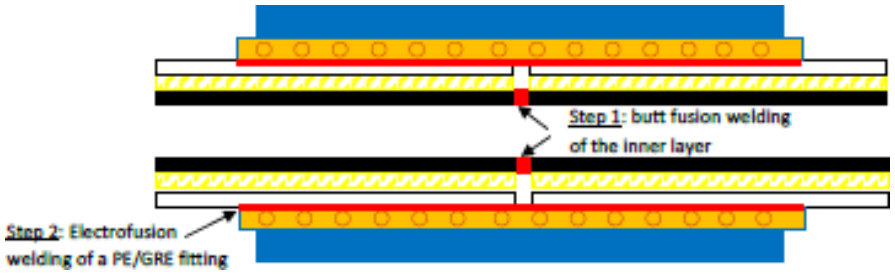
- List of raw materials.
- Description of manufacturing process.
- Results of “Manufacturing Procedure Qualification (MPQ)” or Type tests.
- Results of last process verification tests.

IV.5 APPENDIX-B: WELDING AND QUALIFICATION OF RTP

IV.5.1 General

Welding of RTP is two steps process as listed hereafter:

1) Butt fusion welding of the inner layer.
2) Electrofusion welding of the non-metallic fittings.



The welding qualification shall cover these two steps; three assemblies are typically required to perform all welding qualification tests.

IV.5.2 Butt Welding Qualification

a. Equipment

- Fulfil ISO 12176-1 requirements.
- Have control, monitoring and recording of welding parameters.

b. Essential variables

The following changes of the assembly process shall require a new qualification:

- Any change in planning equipment and working parameters.
- Any change in alignment equipment and procedure.
- Any change in pipe geometry (OD and WT).
- Any change in pipe raw materials.
- Any change in preheating temperature of more than +/- 10 ^{O}C.
- Any change in alignment pressure, preheating pressure and joining pressure of more than +/- 10%.
- Any change in the time between heating element removal and pipes joining of more than +/-5%.
- Any change in the cooling time of more than +/-10%.

c. Procedure

A procedure shall be issued and at least contain:

- Pipe ends preparation description: square ends tolerance, type of equipment, checks … etc.
- Butt welding sequence: all the data listed in the following sketch shall be documented.

Approved welding procedure shall not modified without prior written approval.

d. Assembly

Three assemblies shall be performed in the exact field conditions and following the procedure previously approved by the COMPANY.

These assemblies shall be performed under the supervision of the COMPANY to confirm the suitability and integrity of this butt welding procedure.

e. Inspection and testing

Visual inspection and NDT shall be as per the NDT scope of work, approved ITP and as listed in this document.

Destructive testing shall be:

- A burst test with minimum 4 times the pipe LTHP (LCL) pressure.

- Two tensile test at 9 & 12 O'clock positions as per ISO 13953; the failure mode shall be ductile.

One mid-term creep test shall be performed , four mid-term creep tests shall be performed at Trc ≥ Tdesign at the mean hydrostatic pressure corresponding to a 1000 hours on the product regression curve ; mid-term creep tests shall be above the 97.5% lower confidence limit.

IV.5.3 Electrofusion Welding Qualification

Welding devices with bar code identification shall be used. These devices shall comply with ISO 12176-2 requirements except the manual input requirements are not allowed.

Fittings shall have full traceability following ISO 12176-4 requirements.

a. Essential variables

The following changes of the assembly process shall require a new qualification:

- Any change in preparation: length from pipe OD of more than +/- 2 mm and cutting depth of more than +/-0.5 mm.
- Any change in alignment equipment and procedure
- Any change in pipe geometry (OD and WT).
- Any change in welding equipment (type, trademark, serial number … etc.).

b. Procedure

A procedure shall be issued and at least contain:

- Pipe ends preparation : cutting depth and length from pipe ends shall be measured and recorded
- Drying time and temperature of pipe ends before welding.
- Visual inspection of pipe ends after preparation and acceptance criteria.
- Welding equipment identification and welding procedure.

Approved welding procedure shall not modified without prior written approval.

c. Assembly

Two assemblies shall be performed in the exact field conditions and following the procedure previously approved by the COMPANY.

These assemblies shall be performed under the supervision of the COMPANY to confirm the suitability and integrity of this Electrofusion welding procedure.

d. Inspection and testing

Visual inspection and NDT shall be as per the NDT scope of work, approved ITP and as listed in this document.

Destructive testing shall be:

- A burst test with minimum 4 times the pipe LTHP (LCL) pressure.

- Two tensile test at 9 & 12 O'clock positions as per ISO 13953; the failure mode shall be ductile.

IV.5.4 Non-Destructive Testing

The applicable NDT techniques that will be included in the ITP are:

- Visual inspection; if acceptable then release for NDT.
- Phased array ultrasonic testing (PAUT) including at least the combination of raster A-Scan, B-Scan, S-Scan and Time-Of-Flight Diffraction (TOFD) in order to ensure detectability and appropriate probability of detection. The applicable standards are ASTM E3170, ASTM E3167 & ASTM E3044.
- Evisive microwave system can be used as an alternative of PAUT or as an additional NDT Technique. The applicable standards are ASTM E3101 & ASTM E3102.
- Radiography Testing
    1. Can be used to confirm the results of other NDT techniques or as alternative of other NDT techniques upon the approval of the COMPANY.
    2. Numerical X-Rays or real time X-Rays radioscopy shall be the preferred methods in case of unavailability of PAUT or Evisive microwave.
    3. RT 100% inspection of site assembly shall be performed incompliance with ASME V
    4. Wire type image quality indicator (IQI) according to EN 462-1 shall be used.
    5. Un-sharpness shall be < 0.3mm.
    6. Film system shall be maximum C# according to 11699-1.
    7. As a minimum film identification shall include:
        - Project identification.
        - Line size and identification.
        - Joint number.
        - Date (day / month / year).
        - Location.
        - All films shall be protected in individual plastic bags and stored in aluminium boxes closed with tight fit lids before delivery to the COMPANY. All films boxes shall be individually numbered and indexed on their top.
- All NDT operators shall be qualified &certified as per PCN Level II at least, supervised by PCN Level III and working incompliance with this specification and approved NDT procedures. PCN Level II/Level III can be replaced by equivalent qualification subjected to the COMPANY approval before commencement.
- All NDT techniques shall be illustrated in detailed procedures prepared by PCN Level III and each NDT procedure shall demonstrated by procedure qualification record (PQR) .90-95% is the acceptable range for probability of detection (POD)

with 95% confidence for any utilized NDT technique; manufacturer shall apply ASTM E2862-12 for (POD) determination.

IV.5.5 Acceptance Criteria

The following acceptance criteria shall apply for qualification assemblies:

- No lack of fusion and no porosities in the butt-welded area
- Total defect area shall be <5% of total joint area for the electrofusion welded area
- The non-defective axial adhesive length shall be >90% of total joint length for the electrofusion welded area

The following acceptance criteria shall apply for production assemblies:

- No lack of fusion and no porosities in the butt-welded area
- Total defect area shall be <15% of total joint area for the electrofusion welded area
- The non-defective axial adhesive length shall be >75% of total joint length for the electrofusion welded area.

IV.6 LINE PIPE INFORMATION REQUIREMENTS

All the information of Design, Fluid Composition, Operation Conditions, Dimensions, Materials, Testing and Inspections, Marking, Storage and Transportation shall be mentioned in project data sheet as well as vendor data sheets.