ADNOC GROUP PROJECTS AND ENGINEERING

SPECIFICATION FOR SUBSEA PIPELINE SYSTEMS (AMENDMENTS/SUPPLEMENTS TO DNVGL-ST-F101)

Specification

AGES-SP-10-002

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شركة بترول أبوظبي الوطنية
Abu Dhabi National Oil Company

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 for Subsea Pipeline Systems.

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I Introduction

I.1 OBJECTIVE

I.1.1 This specification defines ADNOC Offshore minimum requirements for design of subsea pipeline systems.

I.1.2 This specification shall be read in conjunction with DNVGL-ST-F101 December 2017, which forms an integral part of it. Section III of this specification includes amendments and supplements to DNVGL-ST-F101 December 2017. All other clauses of DNVGL-ST-F101 December 2017 which are neither modified nor supplemented shall be fully applicable as part of this specification.

I.2 SCOPE

The scope of this specification covers concept development and design of new subsea pipeline system

I.3 COVERAGE

I.3.1 This specification shall be applicable to subsea pipeline and riser systems within pipeline system battery limits as defined below for both manned and unmanned platforms.

I.3.2 For normally unmanned platforms, such as WHT's, this specification shall be applicable for the subsea pipeline system including spool piece and riser up to and excluding minor barrel flange of pig trap.

I.3.3 For normally manned platforms, such as riser platforms & Super Complex, this specification shall be applicable for the subsea pipeline system including spool piece and riser up to and excluding first isolation valve close to the riser.

I.3.4 For shore approach section, this specification shall be applicable up to and excluding first isolation valve installed at the landfall area.

I.4 EXCLUSION

This specification does not cover onshore pipeline sections for which AGES-SP-10-003 applies.

I.5 REFERENCES

I.5.1 General

The latest edition of the reference documentation, on the effective date of award/purchase order, as listed in Table 1-6 shall be read as an integral part of this document.

The latest edition/revision of Company TSDs, on the effective date of award/purchase order, as indicated in the status list A0-ENG-N-SL-001 shall be utilized.

I.5.2 Equivalent Standards

Standard documents equivalent to those referred to herein shall not be substituted without written approval from ADNOC Offshore. Approval of equivalent standard documents shall not, in any way, remove responsibility from Contractor or third parties to meet the best practices and/or requirements of the technical standard documents referred to herein, in the event of conflict.

Any technical deviations to this document and referenced Company TSDs, international codes and standards and project documents, including, but not limited to, the data sheets and job specifications, shall be sought by the Vendor/Contractor as per Company GDL-040 for Company's review and approval, prior to the proposed technical changes being implemented. Any deviation based on non-technical basis, including cost and schedule, shall be rejected. Technical changes implemented prior to Company's approval are subject to rejection.

Where differences and/or conflicting issues occur between the referenced documents themselves or the requirements of this document, the requirements of this document shall prevail unless otherwise advised by ADNOC Offshore. However, all differences/ conflicts shall be reported in writing to the ADNOC Offshore standards team for arbitration/resolution before fabrication commences.

Contractors, Suppliers or third parties shall equip themselves with copies of all the referenced TSDs referred in Table 1-6 of this document and shall make them readily available to all ADNOC Offshore, or nominated representative, personnel involved in the work.

I.5.3 Order of Precedence

In the event of a conflict between this document and the referenced codes and standards, the following hierarchy of adherence shall be followed:

1. UAE statutory legislation and regulations.
2. The ADNOC standards, regulations, and codes of practice.
3. ADNOC Offshore HSE standards & regulations.
4. Project specifications and data sheets.
5. This specification.
6. ADNOC Offshore TSDs.
7. International codes & standards.

I.6 USE OF LANGUAGE

Throughout this document, the words ‘will’, ‘may/can’, ‘should’ and ‘shall/must’, when used in the context of actions by ADNOC Offshore or others, have specific meanings as follows:

a. ‘will’ is used normally in connection with an action by ADNOC Offshore and/or nominated representative, rather than by a supplier.

b. ‘may/can’ is used where alternatives/action are equally acceptable.

c. ‘should’ is used where provision is preferred.

d. ‘shall/must’ is used where a provision is mandatory/vital.

I.7 UNITS

Units shall be in accordance with Company STD-00, Part-1.

II Quality Assurance

II.1 QUALITY ASSURANCE SYSTEM

II.1.1 All activities and services associated with the scope of this document shall be performed by Contractor/Supplier approved by Company.

II.1.2 The Contractor/Supplier shall operate QMS within its organizations, which ensure that the requirements of this document are fully achieved.

II.1.3 The Contractor/Supplier's QMS shall be based on Company A0-Q-PQ-SP-002 or the latest issue of ISO 9001 series and accredited by an international certifying agency.

Where an approved Contractor/Vendor revises their QMS that affect the Company approved QP/ITP, then the revised QP/ITP shall be submitted for Company approval before initiating any service activities.

II.1.4 The effectiveness of the Contractor/Supplier's QMS may be subject to monitoring by Company or its representative and may be audited following an agreed period of notice.

II.1.5 The Contractor/Supplier shall make regular QA audits on all their Sub-Contractors/Suppliers compliance with ISO-9001. Details of these audits shall be made available to Company when requested.

II.1.6 The Contractor/Supplier shall maintain sufficient Inspection and quality assurance staff, independent of the service provider management, to ensure that the QMS is correctly implemented and that all related documentation is available.

II.1.7 Using Sub-Contractors is not allowed for services/functions carried out by Supplier without Company approval.

II.2 QUALITY PLAN

II.2.1 The Contractor's Quality Manual shall provide details for the preparation of a quality plan, which shall include provisions for the QA/QC of services activities. The quality plan shall be submitted to Company for approval. Moreover, in case of any revision in the quality plan due to change in QMS, then the revised QP shall be submitted for Company approval before initiating any service activities.

II.2.2 The level of detail required in the quality plan shall be commensurate with the scope of services provided.

II.2.3 The quality of works is an essential factor in carrying out all services & activities covered by this document.

II.2.4 During services/activities, QA/QC issues are the responsibility of the Supplier, and shall be approved and certified by TPA.

II.2.5 All conflicts among Contractor, Supplier & TPA shall be reported in writing to Company for resolution.

II.3 INSPECTION AND CERTIFICATION REQUIREMENTS

Inspection and certification requirements for material shall be in accordance to Company CP-102 and BS EN 10204.

III Technical Requirements

a. The technical requirements stipulated in this specification are based on DNVGL-ST-F101 Dec. 2017.

b. The numbering of the following items corresponds to the paragraph numbering in DNVGL-ST-F101 Dec 2017 and reflects amendments and/or supplementary requirements by ADNOC Offshore as appropriate.

c. All provisions of DNVGL-ST-F101 Dec. 2017 that are not revised or supplemented shall remain in force. As a result of this, gaps in the numbering may occur. These gaps in the numbering denote that ADNOC Offshore has no additional requirements over those Sections/Subsections and the requirements of DNVGL-ST-F101 Dec. 2017 shall apply in full

SECTION 1 INTRODUCTION

1.7 References

1.7.6 Other references

The following references are added to Table 1-6.

Table 1-6

Document Code	Title
DHI Guidelines	Project Guideline for Protection and Stabilization of Pipelines
ADNOC	
EP-PJT-GM-0008	ADNOC Project Governance List of Deliverables for Select & Define Stages
ADNOC Offshore	
A0-ENG-L-SP-004	Free Span Design & Rectification for Subsea Pipelines
A0-ENG-L-SP-005	Subsea Pipeline Crossing
A0-ENG-L-SP-101	Concrete Weight Coating of Subsea Pipelines
A0-ENG-L-SP-103	Specification for Hydrostatic Testing for Subsea Pipelines
A0-ENG-M-SP-002	Induction Bends in Line Pipe
A0-ENG-N-SL-001	Status List for ADNOC Offshore Technical Standard Documents

Document Code	Title
A0-ENG-Y-SP-001	Specification for Offshore Geophysical Surveys
A0-ENG-Z-PRO-002	Procedure for Management of Facility Changes
A0-IG-C-SP-006	Cathodic Protection of Submarine Pipelines
A0-IG-C-STD-001	Standard for Offshore Bracelet and Cast Galvanic Anodes
A0-IG-P-SP-001	Polypropylene Corrosion Protection Coating of Concrete Weight Coated Carbon Steel Line Pipe
A0-IG-P-SP-002	Field Joint of Polypropylene Corrosion Protection Coating of Concrete Weight Coated Carbon Steel Line Pipe
A0-IG-P-SP-003	Specification for Spun Hot Dip Galvanization & Polytetrafluoroethylene (PTFE) Coating of Nuts/Bolts and Fasteners
A0-IG-P-SP-004	Coating Specification for New and Existing Constructions of Offshore and Onshore Structures
A0-IG-P-SP-005	Specification for Polyethylene Corrosion Protection Coating of Concrete Weight Coated Carbon Steel Line Pipe
A0-IG-P-SP-006	Specification for Field Joint of Polyethylene Corrosion Protection Coating of Concrete Weight Coated Carbon Steel Line Pipe
A0-IG-U-GDL-002	Guideline for Pipeline Intelligent Pigging
A0-IG-U-SP-001	Technical Specification for Control of ROV Inspection of Subsea Pipelines
A0-IG-W-SP-001	Welding, Inspection & Testing of Hot Tap Connections
A0-IG-W-SP-002	Preheat and Post Weld Heat Treatment of Ferrous Materials
A0-IG-W-SP-003	Pipeline Welding
A0-LOG-V-STD-001	OPCO Acceptance Standard for Marine Contractors
A0-Q-PQ-SP-002	Specification for Requirements for Projects Contractor Quality System
A0-Q-PQ-SP-003	Quality Assurance and Quality Control Requirements for Construction Works
AGES-SP-10-001	Specification for Line Pipe (Amendments/ Supplements to API Specification 5L)
AGES-SP-10-003	Onshore Pipelines Design and Construction Specification
CP-036	Integrity Assurance in Projects

Document Code	Title
CP-102	Inspection & Testing Requirements for New Equipment and Materials in Manufacture
CP-104	Cathodic Protection of Corrosion Control Systems on Das Island
GDL-012	Material Selection
GDL-020	Global Buckling Design of Subsea Pipelines
GDL-040	Concession Request
GDL-043	Pipeline Integrity Management System (PIMS)
MRS-STD-02	OPCO Acceptance Standard for Marine Vessels
MSMS-06-OPCO-SIMO	OPCO Standing Instructions for Marine Operations
SP-1000	Material for Sour Services
SP-1002	Preservation of New Material & Equipment
SP-1016 Part-1	Pipeline Cleaning , Flushing & Flooding
SP-1021	Water Quality for Hydrostatic Test
SP-1023	Part-1 Piping Supports
SP-1040	Polychloroprene (Neoprene) Corrosion Protective Coating of Riser Pipes & Clamps
SP-1047	Riser Clamp
SP-1050	Part-1 Mechanical Design Criteria/Piping System
SP-1051	Piping System Stress Analysis
SP-1056	Offshore Trenching and Backfilling
SP-1060	Specification for Process Design Criteria
SP-1063	Shore Approach of Subsea Pipelines
SP-1151	Specification for Valves
STD-00 Part 1	Measurement Units

Document Code	Title
STD-00 Part 2	Site Condition and Data
STD-108	Standard for Flanges
Z0-TS-Z-01010	General Data on Environmental and Climatic Conditions at ZADCO Facilities

1.7.7 Company approved software for pipeline design activities (new section)

The following software are approved by Company for pipeline design activities:

Design Activities	Recommended Software
Wall Thickness	DNVGL-ST-F101 Spreadsheet
On-Bottom Stability	DNVGL StableLines Spreadsheet/ABAQUS
Free Span	DNVGL FatFree Spreadsheet
Riser Flexibility/Stress Analysis	CAESAR II
Pipeline Crossing	ABAQUS
On-Bottom Roughness	ABAQUS
Pipeline installation analysis	Offpipe/OrcaFlex
Global buckling & Walking Analysis	ABAQUS

Note: Alternative equivalent software may be utilized subject to Company approval.

1.8 Definitions

1.8.2 Terms

The following amendments and additions are made to Table 1-8.

Term	Definition
ADNOC Offshore/ Company/Purchaser	The Company based in Abu Dhabi. Also referred to as the customer/Purchaser Organization responsible for placing the purchase order or contract for the supply of goods and/or services. The organization in this case may be the Company or Contractor or their nominated representative
Contractor	The term Contractor includes any entity tasked to deliver full or part of contract scope of work of the design, engineering, procurement, construction, commissioning or management of the project, and covers Vendors, Suppliers, Sub-contractors, Consultants; etc.
ITP	Inspection & test plan prepared by the Manufacturer reviewed and approved by Company highlighting the principal hold and witnessing points during and after the process of the product realization (i.e.: manufacturing, fabrication, construction, installation), to ensure that the quality level of the product is within the acceptable design standards and requirements
Manufacturer	Any and all persons, firms, partnerships, companies, bodies, entities or a combination thereof including sub-suppliers who are fabricating/ constructing the complete equipment access
Quality Assurance	All those planned and systematic actions (QA) necessary to ensure quality i.e. to provide adequate confidence that a product or service will be fit for its intended purpose.
Quality Manual	A document setting out the general quality policies, procedures and practices of an organization
Quality Plan	A document prepared by the Contractor/Vendor setting out the specific quality practices, resources and activities relevant to a particular project
Quality Management System (QMS)	The structure organization, responsibilities, activities, resources and events that together provide organized procedures and methods of implementation to ensure the capability of the organization to meet quality requirements
TPA	Third Party Agency is the company contracted to undertake the third party inspection (TPI) & verification tasks on behalf of ADNOC Offshore
Vendor/Supplier	Any and all persons, firms, partnerships, companies, bodies, entities or a combination thereof including sub-vendors and sub-suppliers, who are providing materials or equipment and/or services of equipment covered by this document (not necessarily the manufacturer)

1.8.3 Abbreviations

The following abbreviations are added to Table 1-9.

Abbreviation	Description
ADNOC Offshore	Abu Dhabi Company for Offshore Petroleum Operations
AGA	American Gas Association
BE	Best Estimate
DHI	Danish Hydraulic Institute
FE	Finite Element
HE	Higher Estimate
LE	Lower Estimate
MSL	Mean Sea Level
OD	Outside Diameter
QAS	Quality Assurance System
QMS	Quality Management System
SWL	Surge Water Level
TPA	Third Party Agency
TSD	Technical Standard Documents
UAE	United Arab of Emirates
WHT	Well Head Tower

SECTION 2 SAFETY PHILOSOPHY

2.3 Risk Basis for Design

2.3.3 Location classes

2.3.3.1 (Addition)

a. The extent of location class 2 shall be as follows:

i. For manned platforms (super complexes):
From first isolation valve close to riser up to 500m from riser bottom bend.

ii. For normally unmanned platforms (WHT's):
From pig trap up to either two pipe joints from the riser bottom bend or the subsea expansion spool, whichever is greater.

iii. For shore approach/landfall area:
500m from tie-in weld/flange at landfall towards offshore.

SECTION 3 CONCEPT AND DESIGN PREMISE DEVELOPMENT

3.2 Concept development

3.2.1 Concept development

3.2.1.3 (Addition)

Design life for subsea pipeline systems shall be 40 years, unless otherwise specified.

3.3 Design premise

3.3.5 Pipeline route

3.3.5.1 (Addition)

a. Pipelines shall not be laid inside the restricted rig approach area. The dimensions of the rig exclusion zone shall be as specified by ADNOC Offshore marine.

b. Avoid permitted anchoring zones and areas of known rock outcrops or coral.

c. Minimize number of crossings and where possible achieve crossing angles higher than 30 degree.

d. Avoid pipeline crossings within proximity of platform approach, existing crossings and on pipeline curves, where possible.

e. Avoid marine operations areas such as maintenance barge access and boat landing locations unless approved by Company.

f. Pipelines shall have a separation of minimum 100 m with existing structures and artificial islands in the field and avoid flare exclusion zones.

g. Pipelines shall be separated by a minimum distance of 20 meters. A separation of less than 20 meters shall be subject to review and approval by Company on a case by case basis. Subject to Company prior approval, the separation between parallel pipelines can be reduced up to 5 m or less at platform approaches and near the landfall area.

h. Provide sufficient straight length at platform approach and before and after route curves to ensure curve stability.

i. Route curvature stability shall be as per the requirements of DNVGL-ST-F109. Route curves at crossings shall consider pipe-sleeper friction coefficients.

j. Pipelines shall preferably be installed within predefined pipeline corridor to avoid unnecessary crossings.

3.3.6 Route survey

3.3.6.1 (Addition)

Offshore geophysical survey shall be in accordance with the requirements of ADNOC Offshore A0-ENG-Y-SP-001.

3.4 System design principles

3.4.2 Pipeline control and safety system

3.4.2.3 (Addition)

Mandatory requirement: Hydrocarbon pipelines initiating from or terminating at a platform shall, as a minimum, have pressure safety systems in the form of ESD valves located at the lowest platform deck above the highest water level.

Subject to HAZOP studies and other techno-economic analysis, HIPPS may be employed to isolate the pipeline system from high pressure topside piping systems. Similarly, requirements of subsea isolation valve system may be determined based on individual pipeline safety considerations.

3.4.2.9 (Addition)

The incidental to design pressure ratio shall be defined based on the process inputs.

SECTION 4 DESIGN - LOADS

4.3 Environmental loads

4.3.3 Hydrodynamic loads

4.3.3.14 (Addition)

For the marine growth data see STD-00 Part 2, Site Condition and Data.

4.3.4 Ice loads (amendment)

Ice loads are not applicable in ADNOC Offshore fields.

4.7 Design load effects

4.7.2 Characteristic load

4.7.2.4 (Addition)

The functional load effects considered for pipeline design activities shall be calculated based on the following:

Design Activities	Temperature	Pressure
Wall thickness	Design	Incidental
Cathodic protection	Maximum operating profile	N/A
Expansion	Design profile	Incidental
Free span (ULS)	Design profile	Incidental
Free span (FLS)	Maximum operating profile	Maximum operating
Riser flexibility/stress analysis	Design profile	Incidental
Pipeline crossing	Design profile	Incidental
On-bottom roughness	Maximum operating profile	Maximum operating
Global buckling	Design profile	Incidental
Pipeline walking	Transient profile	Maximum operating

Section of riser above water, temperature will be the maximum of design temperature or 85°C, whichever is greater.

The pipeline design temperature shall be determined as per Company SP-1060.

SECTION 5 DESIGN – LIMIT STATE CRITERIA

5.2 System design requirements

5.2.1.2 (Addition)

Settlement of pipeline crossing supports shall be taken into consideration while determining the design vertical separation distance to ensure that the minimum vertical distance of 0.3 m is maintained during pipeline operational life.

5.2.1.11 (Addition)

Bend radius of piggable pipeline system shall be 5xD. Any deviation shall be supported by confirmation from at least three Company approved IP vendors and subject to Company approval. Bends shall include a minimum bend tangent length of 500 mm or 1.5 D, whichever is greater.

Pipeline system shall be designed for pigging including internal pipeline inspection by intelligent pigs unless specified otherwise. Piggability assurance study shall be carried out during FEED and EXECUTE stages. It shall cover the following as a minimum:

a. ID variation.

b. Bend radius.

c. In case of transition between different pipe wall thicknesses, internal tapering of 1:4 shall be performed at the tie-in joint to ensure smooth passage of the pig.

5.4 Limit states

5.4.8 Fatigue and fracture limit state

5.4.8.13 (Addition)

Knock-down factors to be applied to the in-air S-N curves for weld root of sour service pipelines as per the below equation:

$$\text{Knock down factor} = 2 \times 10^{(2.63+0.34 \log pH_2S - 0.46pH)}$$

In all cases, knock down factor shall be minimum 10 and maximum 40.

5.5 Special considerations

5.5.2 Pipe soil interaction (addition)

Pipe-soil interaction study shall be carried out based on geotechnical survey and associated laboratory testing results in accordance with DNVGL-RP-F114. Selection of soil models and parameters shall take into account the site-specific soil conditions, soil variability, pipeline properties including the laying conditions, pipe soil interface and drainage conditions, including the effect of carbonate content.

Soil zoning for pipe-soil interaction assessment shall be carried out based on existing geophysical and geotechnical data.

Pipe-soil interaction study shall include calculation of probabilistic ranges including LE, BE and HE values of the following parameters:

a. As-laid pipeline embedment based on pipe properties (diameter, weight, surface roughness etc.) and loading history (laying, flooding, dewatering etc.). Pipeline embedment calculation shall consider static touchdown factor and dynamic pipe lay effects.

b. Static and dynamic vertical seabed stiffness.

c. Mobilization displacement, residual axial resistance and breakout/residual lateral resistance based on calculated as-laid pipeline embedment. Soil resistance calculation shall consider soil drainage conditions based on pipeline loading rate (e.g. fast loading rate for hydrodynamic loads vs. slow loading rate for thermal expansion). Soil resistance values shall be expressed as equivalent friction factors i.e. resistance divided by the pipeline weight.

5.5.3 Global buckling (addition)

Global buckling and walking design shall be in accordance with the requirements of ADNOC Offshore GDL-020.

Detailed global buckling & walking FE analysis utilizing ABAQUS shall be carried out during FEED and EXECUTE stages. Native FE files shall be furnished to Company.

5.5.4 Free spanning pipelines (addition)

Free span analysis for pipelines shall be performed in accordance with ADNOC Offshore A0-ENG-L-SP-004.

5.5.5 On bottom stability (addition)

Directional wave and current shall be extracted from Company's Deltares environmental database and utilized for pipeline on-bottom stability analysis.

Design water depth shall be as per below table:

Design Condition	Design Water Depth
Installation	Minimum water level relative to LAT + storm surge for 10 year
Operation	Minimum water level relative to LAT + storm surge for 100 year
Where: storm surge= SWL - HAT	

For pipeline sections resting on seabed, the stability analysis shall be as per the generalized method specified in DNVGL-RP-F109 maximum displacement of 10D for zone-1 and 0.5D for zone-2, where D is the overall pipeline outer diameter including coating. Half corrosion allowance shall be considered for operation condition while no corrosion allowance shall be considered for installation condition.

The extent of zone-2 shall be 500 m from riser bottom bend at platform approach and 500 m from landfall towards offshore at shore approach. The remaining route resting on seabed shall be considered as zone-1.

For pipeline sections at crossing locations up to a minimum of 100 m beyond touchdown points, the below design criteria shall be applied for various projects' phases:

a. Stability assessment at crossings for project in Select phase
The on-bottom stability analysis at crossing locations shall be performed in accordance with generalized method for virtually stable pipe of a maximum lateral displacement of 0.5D.

b. Stability Assessment at Crossings for Project in FEED and Execute phases
Dynamic on-bottom stability analysis shall be performed during FEED/Execute engineering phases using finite element software to verify adequacy of required concrete weight coating thickness based on generalized method 0.5D criterion. The dynamic stability analysis shall be performed using ABAQUS software and shall be in accordance with requirements of DNVGL-RP-F109. The maximum allowable lateral displacement at crossing locations shall be limited to 0.5D in both installation and operation conditions unless otherwise approved by Company.

ABAQUS software model shall include following elements as a minimum:

1. Pipe/soil interaction based on LE lateral pipe-soil resistance.

2. Pipe-sleeper interface friction coefficient as applicable. A friction coefficient of 0.5 shall be used for concrete-concrete interface.

3. Hydrodynamic force model to generate the hydrodynamic loads on the pipeline during the 3 hours random sea state. The model shall transform surface wave spectrum to a time series for the wave induced particle velocity at the pipe level on the seabed. Steady current velocity shall be added to the wave induced velocity. The hydrodynamic lift, drag and inertia forces on the pipeline shall be calculated based on the Fourier coefficients model developed by DHI for AGA or alternatively, classical Morison's equation can be utilized with appropriate hydrodynamic coefficients as given in DNVGL-RP-C205 considering pipe elevation above seabed and further outlined hereunder:

   i. Lift coefficient (C_L): As per Figure 6-4 of DNV RP C205 (for pipeline resting on seabed a value of 0.9 shall be considered)
   ii. Added mass coefficient (C_A): As per Figure 6-9 of DNV RP C205,
   iii. Drag coefficient (C_D): As per subsection 6.7 of DNV RP C205 and shall consider the effects of Reynold's number, roughness, Keulegan-Carpenter number and wall interaction.

For trenched pipeline section at shore approach, the pipeline stability shall be ensured for the installation condition as per generalized method for maximum lateral displacement of 0.5D.

In case concrete coating thickness exceeds practical limits based on pipeline size, installation limitations and coating mill capabilities, concrete flexible mattresses can be used to restrain the movement of the pipeline on the seabed. The mattress shall be designed to withstand the anticipated hydrodynamic loading and shall be self-stable. The mattress self-stability shall be assessed in accordance with DHI guidelines “Project Guideline for Protection and Stabilization”.

Other additional stabilization solutions may be proposed and in all cases due consideration shall be given to techno-economical merits and shall be subject to Company review and approval.

5.5.6 Trawling interface (amendment)

Trawling interference is not applicable for ADNOC Offshore fields.

5.5.7 Third party loads, dropped objects (addition)

Pipeline design shall consider vessel-anchoring interference where possibility of anchor interference exists, such as shipping channels. If required, mechanical protection shall be provided by trenching and backfilling in accordance with Company SP-1056.

Pipeline sections at the shore approach shall be trenched as per ADNOC Offshore SP-1056 requirements.

5.5.12 Piggy-back arrangements (new section)

5.5.12.1 General

The design of piggy-back arrangement of small diameter pipeline or cable over a larger diameter carrier pipeline shall consider the following:

a. Design of the main pipeline and piggy-back lines shall be integrated seamlessly so that differential expansions between piggy-back lines with respect to main lines at riser bottom or route curvatures/spooks/crossings are addressed and overstressing is avoided.

b. The piggy-back spacers and any strapping system shall have minimum life span equal to the life of pipelines themselves.

c. Piggy-back block and the strapping system materials shall not be damaging to environment.

d. The spacer spacing shall be determined so that the piggy-back pipeline/cable does not suffer from fatigue failure.

e. Piggy-back pipeline/cable should normally be located between 11 and 1 hour position on top of the carrier pipeline.

f. Maximum two nos. of piggy-back pipelines/cables shall be allowed on a main pipeline.

g. If there is risk of damage due to shipping or fishing then the system shall be provided with appropriate protection.

5.5.12.2 Corrosion protection and cathodic protection

The carrier pipeline and the piggy-back pipeline shall be cathodically protected by a combined CP system; the design shall be supported by detailed calculations.

The carrier pipeline and the piggy back pipeline shall be electrically connected at pre-determined intervals as per design calculations. The preferred method will be to attach the bonding cable to the carrier pipeline at the field joint. Alternative methods shall be subject to review and approval by Company.

5.5.12.3 Stability and spanning

For the spanning analysis of the piggy back pipeline, the flow enhancement shall be computed in accordance with the following equation:

$$V_i = V_u\left[1 + \frac{R^2}{Z^2}\right]$$

Where;

V_i = Increased velocity

V_u = Nominal velocity

R = Radius of main pipeline inclusive of external coatings

Z = Distance between centerlines of main pipeline and piggy back line

Alternative methods shall be subject to Company review and approval.

Note: For the on-bottom stability and free span analysis of main line, hydrodynamic loads shall be calculated based on an equivalent diameter equal to the height from the bottom chord of the main line to the top chord of the piggy back line or the main line, whichever is higher. Alternative methods may be proposed for Company review and approval.

5.5.13 Requirements for riser system (new section)

a. Pipeline to riser tie-in by welding shall normally be performed by above water stalk-on method. For new jackets, and subject to safety studies, risers shall be pre-installed to the inner face of the jacket and pipeline to riser tie-in shall be by means of subsea flanges.

b. Splash zone lower limit shall be between (MSL – 2.5m) to (MSL + 4.0m).

c. A hanger flange welded to the riser shall rest on the hanger clamp to support the full weight of the riser. In case of retrofit risers, the hanger clamp shall itself be clamped to the platform. The hanger clamp shall be away from the splash zone as far as possible.

d. The hanger flange shall be designed to support the full riser dead load and loads caused by environmental forces on the riser. A minimum edge to edge clearance of 500mm shall be maintained between adjacent hanger flanges.

e. To prevent/limit lateral movements of the riser, guide clamps shall be installed at suitable intervals. To assure proper alignment of riser, a minimum of one riser clamp above seawater level and one riser clamp below seawater level shall be installed. The maximum allowable span lengths between the clamps shall be determined in accordance with A0-ENG-L-SP-004.

f. Riser clamps shall not be installed in the splash zone unless deemed unavoidable and approved by Company. If a r

g. iser clamp is located in the splash zone, it shall be adequately protected against increased risk of corrosion. The riser clamp design shall meet the requirements of Company SP-1047.

h. Riser shall be protected by polychloroprene corrosion coating (neoprene) in accordance with ADNOC Offshore SP-1040. No additional corrosion allowance for splash zone shall be applied.

i. Flexibility analysis for the riser/expansion spool shall be carried out using the software CAESAR II. The stresses in the riser and expansion spool under worst loading conditions shall be verified and the adequacy of the riser wall thickness shall be determined. The worst case combinations of functional and environmental loads shall be applied and the resulting stresses checked against the local buckling check as per combined loading criteria defined by Sec 5.4.6 of DNVGL-ST-F101 and allowable stress check as per Sec 5.6.2 of DNVGL-ST-F101 for bends. The analysis shall be carried out for various loading combinations as listed below:

    1 Operation Condition: Functional loads due to design temperature and incidental pressure, and worst-case anticipated operating end expansion. Maximum product density case is considered. Environmental loads comprise of 100-year maximum wave (maximum wave height and associated period) and 10-year current, with 100-year platform deflection loads and considering marine growth.

    2 Hydrotest Condition: Functional loads due to hydrostatic test pressure and temperature, pipeline expansion and hydrotest water density. Environmental loads consist of 10-year maximum wave (maximum wave height and associated time period of maximum wave), and 1-year current, with 10-year platform deflection loads.

    3 Flooded Condition: Riser at ambient condition flooded with hydrotest water. Environmental loads consist of 10-year maximum wave (maximum wave height and associated time period of maximum wave), 1-year current, with 10-year platform deflection loads.

j. Stress analysis for the riser/expansion spool shall consider the corrosion allowance as defined below: 100% fully corroded for structural flexibility of the model for operation condition and non-corroded wall thickness for Hydrotest/Flooded condition.

k. The hydrodynamic coefficients utilized in the riser stress model shall be for smooth riser surface (Hydrotest and Flooded Conditions) and rough riser surface (Operation condition) as per the requirements of DNVGL-RP-C205.

l. The Dynamic effects from slug loading shall be included in the riser stress model in line with Section 13 of Company SP-1051.

m. The riser stress model shall be extended (as a minimum) till the first anchor point on the topside platform area and shall be extended on the seabed at least for 50m away from subsea expansion spool.

n. Native CAESAR II files for the riser stress model shall be furnished to Company.

SECTION 6 DESIGN – MATERIALS ENGINEERING

6.2 Materials Selection for Line Pipe and Pipeline Components

6.2.1 General (Addition)

Pipeline material selection shall be in accordance with ADNOC Offshore GDL-012.

6.4 Corrosion Control

6.4.5 Cathodic Protection (Addition)

The requirements for the cathodic protection design is covered in ADNOC Offshore A0-IG-C-SP-006.

SECTION 7 CONSTRUCTION – LINE PIPE

7.1 General (Addition)

Carbon-Manganese (C-Mn) line pipe shall satisfy the requirements for materials, manufacture, testing and documentation of AGES-SP-10-001.

Any conflicts between the above specification and DNVGL-ST-F101 shall be identified and notified to Company for resolution.

Corrosion Resistant Alloy (CRA), and CRA clad or lined C-Mn pipes shall satisfy the requirements of DNVGL-ST-F101. The pressure containing C-Mn pipe for the clad or lined pipe shall meet the requirements of above ADNOC specification.

SECTION 8 CONSTRUCTION - COMPONENTS AND PIPELINE ASSEMBLIES

8.2 Component Requirements

8.2.3 Induction Bends – Additional and Modified Requirements to ISO 15590-1 (Addition)

Induction bends material, design and fabrication shall be in accordance with ADNOC Offshore A0-ENG-M-SP-002. Mitre bends shall not be used.

8.2.5.1 Flanges and Flanged Connections – Additional Requirements to ISO 15590-3 (Addition)

Flanges material, design and fabrication shall be in accordance with ADNOC Offshore STD-108.

8.2.6 Valves – Additional and Modified Requirements to ISO 15590-1 (Addition)

Valves material, design and fabrication shall be in accordance with ADNOC Offshore SP-1151.

SECTION 9 CONSTRUCTION - CORROSION PROTECTION AND WEIGHT COATING

9.2 External corrosion protective coatings

9.2.1 General (Addition)

Polypropylene external corrosion protection coating shall be in accordance with the requirements of ADNOC Offshore A0-IG-P-SP-001. Polyethylene external corrosion protection coating shall be in accordance with the requirements of ADNOC Offshore A0-IG-P-SP-005.

Field joint of polypropylene corrosion protection coating of concrete weight coated carbon steel pipeline shall be in accordance with the requirements of ADNOC Offshore A0-IG-P-SP-002. Field joint of polyethylene corrosion protection coating of concrete weight coated carbon steel pipeline shall be in accordance with the requirements of ADNOC Offshore A0-IG-P-SP-006.

External corrosion coating for subsea bends shall be in accordance with the requirements of CPS 101 in ADNOC Offshore A0-IG-P-SP-004.

Topside pipeline section including bends shall be coated as per the requirements of ADNOC Offshore A0-IG-P-SP-004.

9.3 Concrete weight coatings

9.3.1 General (Addition)

Concrete weight coating shall be in accordance with the requirements of ADNOC Offshore A0-ENG-L-SP-101.

SECTION 12 DOCUMENTATION

12.1 General (Addition)

Project deliverables anticipated in each project phase shall, as a minimum, be in accordance with ADNOC project governance list of deliverables for Select & Define stages EP-PJT-GM-0008.

In EXECUTE stage, the following as-built drawings shall be submitted as minimum:

a. As-built alignment sheets.
b. As-built platform approach drawings.
c. As-built riser general arrangement drawings.
d. As-built crossing general arrangement drawings.

SECTION 13 COMMENTARY (INFORMATIVE)

13.7 Installation

13.7.3 (Addition)

During FEED, static pipe lay analysis shall be performed with a typical lay vessel configuration for local Installation contractors.

During EXECUTE stage, a comprehensive static and dynamic installation analysis shall be performed based on nominated pipe lay vessel data and defined limiting pipe lay sea state.

The following criteria shall be considered:

i. Over bend simplified strain and stress criteria.
ii. Sag bend local buckling combined loading criteria (load-controlled condition).
iii. Concrete crushing strain limit.

Pipeline/riser construction engineering shall include, but not necessarily be limited to, the following:

a. Pipeline stacking analysis.
b. Pipeline start up/lay down analysis.
c. Pipelay for various concrete weight coating thicknesses and water depths (static and dynamic).
d. Abandonment and recovery analysis.
e. Davit lift analysis.
f. Above water/mid line tie-in analysis (as applicable).
g. Lateral shift analysis (as applicable).
h. Shore pull analysis (as applicable).
i. Design of buoyancy requirements, pulling winch capacity, sheet pile protection (as applicable).
j. Weld repair analysis.
k. Riser/spool lift analysis.

l. Design of installation aids such as start-up head, lay down head, shore pull head and other components used during construction/installation.
m. Sea fastening design during load-out and transportation of concrete coated pipes, concrete sleepers and mattresses.
n. Local buckling analysis.
o. Temporary support calculations
p. Pipeline lift analysis (as applicable).
q. Startup arrangement drawing.
r. Stinger roller configuration drawing.
s. Davit arrangement drawing.
t. Riser/spool installation drawing.
u. Sea fastening drawings.
v. Installation aid drawings.
w. Shore pull arrangement details (as applicable).

APPENDIX C WELDING

C.1 General (Addition)

All welding activities on the pipeline system fabrication and installation shall conform to the requirements of Company A0-IG-W-SP-003. Any conflict between A0-IG-W-SP-003 and DNVGL-ST-F101 shall be identified and notified to Company for resolution.

APPENDIX F REQUIREMENTS FOR SHORE CROSSING AND ONSHORE SECTIONS

F.1 General (Addition)

Shore approach design shall be in accordance with the requirements of Company SP-1063.