ADNOC GROUP PROJECTS AND ENGINEERING

DESIGN CRITERIA FOR STATIC EQUIPMENT

Specification

AGES-SP-06-001

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شركة بترول أبوظبي الوطنية
Abu Dhabi National Oil Company

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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 Design Criteria for Static Equipment.

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GENERAL

1 PURPOSE

Introduction

This specification provides the minimum requirement for Design Criteria for Static Equipment (standalone or within process & utility packages) which are intended to be constructed in accordance with ASME Section VIII Division 1 or ASME Section VIII Division 2.

2 SCOPE

This Specification gives criteria for the mechanical design for the construction of static equipment of the following types.

a. Pressure Vessels including pressure containing equipment such as Columns, Towers, Drums, Filters / Separators / Coalescers / Strainers, Pulsation Dampers, Tanks and Spheres (designed as per ASME Section VIII) and Electric heaters (excluding electrical and control components)
b. Pig Launchers and Receivers for ADNOC Offshore facilities designed as per ASME Section VIII
c. Shell and Tube Heat Exchangers, Waste Heat Boilers
d. Air Coolers
e. Plate heat exchangers

Note:

Specific criteria for individual items of equipment will be furnished on the mechanical data sheets/drawings.

3 DEFINED TERMS / ABBREVIATIONS / REFERENCES

3.1 Defined Terms:

COMPANY: ADNOC Group of Companies.

CONCESSION REQUEST: A deviation requested by the CONTRACTOR or VENDOR, usually after receiving the contract package or purchase order. Often, it refers to an authorization to use, repair, recondition, reclaim, or release materials, components or equipment already in progress or completely manufactured but does not meet or comply with COMPANY requirements. A CONCESSION REQUEST is subject to COMPANY approval

CONTRACTOR: The party(s) who will carry out all or part of the Design Engineering, Procurement, Construction and Commissioning or Management of the Project.

CYCLIC SERVICE: Cyclic and dynamic reactions from any pressure or thermal loading source that require fatigue analysis per Part 5.5 of ASME Section VIII, Div.2.

DESIGN CODE: ASME Boiler and Pressure Vessel Code Section VIII, Division 1 or ASME Section VIII Division 2, as specified on the datasheet.

ENGINEER: The Engineering Company or entity responsible for specifying, on the Equipment datasheet, the design requirements for equipment

GENERAL SERVICE: Other than hydrocarbon service (e.g. Utility and non-critical services).

HYDROCARBON SERVICE: Process streams of liquid or gaseous hydrocarbon materials, including two and three phase hydrocarbon materials.

LETHAL SERVICE: Equipment contents containing a concentration of poisonous gas or liquid that is dangerous to life when inhaled, such as hydrogen sulfide. Lethal service definition shall be as per Process Design Criteria Company, Isolation, vent and Drain Philosophy and as specified in the process datasheet

GUARANTEE: The party(s) that undertake Mechanical or Process Design functions shall Guarantee Mechanical / Process / Hydraulic performance within agreed contractual parameters.

MANUFACTURER/ SUPPLIER/SUB-SUPPLIER/SUB-CONTRACTOR: Any and all persons, firms, partnerships, companies, bodies, entities or a combination thereof including suppliers, sub-suppliers who are responsible for designing, fabricating and constructing the equipment or who are providing equipment and/or services of equipment covered by this document

NATIONAL BOARD: The National Board of Boiler and Pressure Vessel Inspectors, an organization whose members are the jurisdictional officials responsible for enforcing and administrating the rules of the ASME Boiler and Pressure Vessel Code Section VIII division 1 and ASME Section VIII, Division 2. Vessels meeting requirements of the Code and stamped with the Code “U” or “U2” symbol, shall be registered with the National Board.

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: 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.

SHALL and SHOULD: The word ‘Shall’ is to be understood as a mandatory and the word ‘Should’ as strongly recommended to comply with the requirements of this document.

TPA: Third Party Agency.

UTILITY SERVICE: Water, air and nitrogen services.

VESSEL: Pressure Vessel. It is a container that falls within the scope of ASME Section VIII and is subject to an internal pressure greater than 15 psi or with vacuum of 15psi.

VENDOR: The party(s), which manufactures and/or supplies equipment, technical documents/drawings and services to perform the duties specified by COMPANY/CONTRACTOR.

SUB-VENDOR: The party(s) which carries out all or part of the design, procurement, installation and testing of the System(s) as specified by the CONTRACTOR/VENDOR.

WARRANTY: The party(s) undertaking manufacture of any part of the equipment shall give warranties for workmanship and materials.

3.2 Abbreviations

Abbreviations	
ADNOC	Abu Dhabi National Oil Company
CoP	Code of Practice
CR	Criticality Rating
CFD	Computational Fluid Dynamics
CRA	Corrosion Resistance Alloy
CS	Carbon steel
FEA	Finite Element Analysis
HSE	Health, Safety and Environment
LODMAT	Lowest One Day Mean Ambient Temperature
MAP	Maximum Allowable Pressure
MAWP	Maximum Allowable Working Pressure
MDMT	Minimum Design Metal Temperature
NPS	Nominal Pipe Size
NDE	Non-Destructive Examination
P&ID	Piping & Instrument Diagram
PMS	Piping Material Specification
PWHT	Post Weld Heat Treatment
QA	Quality Assurance
TSD	Technical Standard Documents
WIV	Wind Induced Vibrations
WRC	Welding Research Council

3.3 UNITS

Units shall be in accordance with Company Standard for Measurement Units. All measurements and units will be in accordance with SI standards, except for diameters of pipe, which shall be expressed in inches NPS and unit of pressure which shall be expressed in bara or barg. Units of some quantities are listed below shall be followed unless otherwise specified in other documents.

Quantity	Units	Symbol
Pressure	Bar (a-absolute, g-gauge)	Bara/barg
Temperature	Degree Celsius	°C
Length	Meter or millimeter	m or mm
Volume	Cubic meter	m^3
Volume flow rate	Cubic meters per hour	m^3/hr
Mass	Kilograms	kg

Quantity	Units	Symbol
Mass flow rate	Kilogram per hour	kg/hr
Density	Kilogram per cubic meter	kg/m^3
Force	Newtons or kiloNewtons	N or kN
Heat	Kilojoule	kJ
Specific Heat	Kilojoule per kg per degree	kJ/kg °C
Heat transfer rate	Kilowatt	kW
Heat flux	Kilowatt per square meter	kW/m^2
Power	Kilowatt	kW
Viscosity	Centipoise	cP
Nominal pipe size	Inches	in
Velocity	Meters per second	m/s
Fouling factor	Squared meter Kelvin per Watt	m^2K/W

3.4 LANGUAGE

All Documents and Correspondences shall be in English language.

SECTION A

4 NORMATIVE REFERENCES

International Codes and Standards

The following Codes and Standards shall, to the extent specified herein, form a part of this Specification. When an edition date is not indicated for Code or Standard, the latest edition (including addenda) in force at the time of contract award shall apply.

American Petroleum Institute (API)	
API 510	Pressure Vessel Inspection Code: In-Service Inspection, Rating, Repair and Alterations
API 521	Pressure-Relieving and De-pressuring Systems
API 660	Shell and Tube Heat Exchangers
API 661	Petroleum, petrochemical and natural gas industries—Air-cooled heat exchangers
API 662	Plate Heat Exchangers for General Refinery Services: Part 1— Plate and Frame Heat Exchangers Part 2— Brazed Aluminum Plate-fin Heat Exchangers
API RP 2A-WSD	Planning, Designing and Constructing Fixed Offshore Platforms – Working Stress Design
American Society of Civil Engineers (ASCE)	
ASCE Standard 7	Wind Loads Guide to Wind Load Provision of ASCE 7
ASCE Standard 7	Seismic Loads Guide to Seismic Load Provision of ASCE 7
ASCE	Task Committee report on Seismic Evaluation & Design of Petrochemical Facilities
American Society for Nondestructive Testing (ASNT)	
ASNT CP-189	Standard for Qualification and Certification of Nondestructive Testing Personnel
American Society of Mechanical Engineers (ASME)	
ASME Sec II–Part A	Ferrous Material Specifications
ASME Sec II–Part B	Non-Ferrous Material Specifications
ASME Sec II–Part C	Material Specification for Welding rods, Electrodes and Filler Metals
ASME Sec II–Part D	Material Properties
ASME Section V	Non-destructive Examination
ASME Sec VIII Div.1	Rules for Construction of Pressure Vessels
ASME Sec VIII Div. 2	Rules for Construction of Pressure Vessels (Alternative Rules)
ASME Section IX	Qualification Standard for Welding, Brazing and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators
ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	Pipe Threads, General Purpose (Inch)
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.9	Factory made Wrought Butt Welding Fittings
ASME B16.11	Forged Steel Fittings, Socket Welding and Threaded
ASME B16.20	Metallic Gaskets for Pipe Flanges-Ring-Joint, Spiral-Wound, and Jacketed

ASME B16.21	Non-metallic Flat Gaskets for Pipe Flanges
ASME B16.25	Butt-welding Ends
ASME B16.47	Large Diameter Steel Flanges NPS 26 through NPS 60
ASME B 31.3	Process Piping
ASME B 36.10M	Welded and Seamless Wrought Steel Pipe
ASME B 36.19M	Stainless Steel Pipe
ASME B46.1	Surface Texture (Surface Roughness, Waviness, And Lay)
ASME BTH-1	Design of Below-the-Hook Lifting Devices
ASME PCC-1	Guidelines for Pressure boundary bolted flange joint assembly
ASME STS-1	Steel Stacks
American Welding Society (AWS)	
AWS D1.1	Structural Welding – Steel
British Standards Institution (BSI)	
BS EN 1991-1-4	Eurocode 1 - Actions on Structures, Part 1-4: General actions -Wind actionsloads
BS EN 10204	Metallic Products – Types of Inspection Documents.
BS EN 13121	GRP Tanks and Vessels for use above ground Part 1- Raw Materials - Specification conditions and acceptance conditions Part 2 - Composite materials - Chemical resistance Part 3 - Design and workmanship Part 4 - Delivery, installation and maintenance
PD 5500	Specification for Unfired Fusion Welded Pressure Vessels
International Organization for Standardization (ISO)	
ISO 9001	Quality Management Systems – Requirements
ISO 9004	ISO 9004 Quality management -- Quality of an organization -- Guidance to achieve sustained success
ISO 9809 Parts 1-4	Gas Cylinders - Refillable seamless steel gas cylinders - Design, construction and testing
ISO 3690	Welding and Allied Processes-Determination of hydrogen content in arc weld metal.
Abu Dhabi International Building Code	
ADIBC	Abu Dhabi International Building Code
National Association of Corrosion Engineers (NACE)	
NACE MR0175 / ISO 15156, Parts 1-3	Petroleum and Natural Gas Industries – Materials for Use in H2S Containing Environments in Oil and Gas Production: Part 1 - General Principles for the Selection of Cracking- Resistant Materials Part 2 - Cracking-Resistant Carbon and Low Alloy Steels, and the Use of Cast Irons Part 3 - Cracking-Resistant CRAs (corrosion-resistant alloys) and other alloys
NACE MR 0103	Petroleum, petrochemical and natural gas industries — Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments
NACE SP0198	The Control of Corrosion under Thermal Insulation and Fireproofing – A Systems Approach
NACE SP0387	Metallurgical and Inspection Requirements for Cast Galvanic Anodes for Offshore Applications

NACE SP0575	Internal Cathodic Protection (CP) Systems in Oil-Treating Vessels
NACE SP0590	Prevention, Detection and Correction of De-aerator Cracking
NACE SP0472	Methods and controls to prevent in-service environmental cracking of carbon steel weldments in corrosive Petroleum Refining Environment
NACE TM0177	Laboratory Testing of Metals for Resistance to Sulfide Stress Cracking and Stress Corrosion Cracking in H2S Environments
NACE TM0284	Evaluation of Pipeline and Pressure Vessel Steels for Resistance to Hydrogen-Induced Cracking
NACE TM0103	Laboratory Test Procedure for Evaluation of SOHIC Resistance of Plate Steels Used in Wet H2S Service
The Society For Protective Coatings (SSPC)	
SSPC-SP 6/NACE No 3	Commercial Blast Cleaning
Welding Research Council (WRC)	
WRC Bulletin 297	Local Stress in Spherical and Cylindrical Shells due to External Loadings on Nozzles – Supplement to WRC Bulletin No. 107
WRC Bulletin 368	Stresses in Intersecting Cylinders subjected to pressure
WRC Bulletin 537	Precision Equations and Enhanced Diagrams for Local Stresses in Spherical and Cylindrical Shells Due to External Loadings for Implementation of WRC Bulletin 107
TEMA	
TEMA	Standards of the Tubular Exchanger Manufacturers Association
Miscellaneous	
AISC	ASDAISC Manual of Steel Construction: Allowable Stress Design
	Zick, L.P. Stresses in Large Horizontal Cylindrical Pressure Vessels on Two Saddle Supports, The Welding Journal Research Supplement, Sep. 1951
	Roark's Formulas for Stress and Strain - 8th Edition by Warren Young, Richard Budynas

5 REFERENCE DOCUMENTS

5.1 ADNOC Specifications, Standard Drawings and Other References

The following reference documents, to the extent specified herein, form a part of this specification. When an edition/revision date is not indicated for a document, the latest edition/revision in force at the time of the contract shall apply.

Structural Steel Supply, Fabrication And Erection Specification	AGES-SP-01-002
Structural Design Basis – Onshore Specification	AGES-SP-01-003
Pressure Vessel Specification	AGES-SP-06-002
Shell and Heat Exchanger Specification	AGES-SP-06-003
Material Selection Guidelines & Specifications	AGES-SP-07-001
Specifications for Cathodic Protection	AGES-SP-07-002
Isolation, Drain and Vent Philosophy	AGES-PH-08-001
Process Design Criteria	AGES-SP-08-002
Piping Basis of Design	AGES-SP-09-001
Piping Material Specification Index	AGES-SP-09-002

5.2 ADNOC Group Companies Requirement

The following Annexures list documents provides specific ADNOC Group COMPANIES requirements to be followed in addition to the requirement in this specification.

ANNEXURE 1 ADNOC Gas Processing, Additional References and Requirements
ANNEXURE 2 ADNOC Refining, Additional References and Requirements
ANNEXURE 3 ADNOC Borouge, Additional References and Requirements
ANNEXURE 4 ADNOC Onshore, Additional References and Requirements
ANNEXURE 5 FERTIL, Additional references and Requirements
ANNEXURE 6 ADNOC Offshore, Additional References and Requirements

6 DOCUMENT PRECEDENCE

It shall be the CONTRACTOR or VENDOR'S responsibility to be knowledgeable of the requirements of the referenced Codes and Standards.

The VENDOR shall notify the CONTRACTOR of any conflict between this Specification, the related vessel data sheets/drawings, the Codes and Standards and any other specifications noted herein.

Resolution and/or interpretation precedence shall be obtained from the COMPANY in writing before proceeding with the design/manufacture.

Unless specifically stated/agreed with COMPANY, the most stringent requirements shall apply.

In case of conflict, the order of precedence shall be:

a. UAE Federal Acts and Regulations
b. Design Data Sheets
c. Project Specification
d. COMPANY Specification and Standard Drawings
e. International Codes and Standards

For HSE requirements, Contractors/Consultant shall be responsible for complying with the following hierarchy in their works/activities:

a. The Laws of the UAE
b. The ADNOC Standards, regulations, practices and procedure
c. ADNOC Offshore HSE Standards & Regulations

7 SPECIFICATION DEVIATION/CONCESSION CONTROL

This specification is complementary to requirements of certifying authority, legislative requirement, guidance note issued by any authority & documents referenced herein. Compliance with this Specification & Standards and documents referenced therein does not relieve SUPPLIER of his responsibility to furnish units of proper design, workmanship & materials to meet the specified conditions & duties required in data sheet.

Deviations to this Specification are only acceptable where the CONTRACTOR/VENDOR has listed in his quotation the requirements he cannot comply with and the COMPANY/CONTRACTOR has accepted in writing these deviations before the order is placed.

In the absence of a list of deviations, it will be assumed that the CONTRACTOR/VENDOR complies fully with the Specification.

Post Purchase order, any technical deviations to the Purchase Order and its attachments shall be sought by the CONTRACTOR/VENDOR only through Concession Request procedure and formats. All Concession Requests require the Company's review/approval, prior to the proposed technical changes being implemented.

The COMPANY decision shall be final without any cost & schedule impact to the COMPANY/project.

Technical changes implemented prior to Company approval are subject to rejection.

SECTION B

8 DESIGN CONSIDERATIONS /MINIMUM DESIGN REQUIREMENTS

8.1 Design

Pressure Vessels shall be designed in accordance with ASME Section VIII Division 1 or 2 as indicated in Mechanical Datasheets.

All type of Static Equipment in cyclic service or in the creep range of the materials of construction shall be designed as per ASME Section VIII Division 2, Class 2 and the requirement in the specification.

All types of Pressure Vessel with the nominal thickness of the shell or head exceeding 40 mm shall be designed as per ASME Section VIII Division 2, Class 1 or 2 as per economic benefits and the requirement in the specification.

User Design Specification (UDS) shall be prepared by Contractor/Engineer for pressure vessels designed in accordance with ASME Section VIII Division 2.

Compliance with non-mandatory appendices “G” of ASME Sec VIII Div.1 is mandatory irrespective of equipment design code.

Shell & Tube Heat Exchangers shall be designed in accordance with ASME Section VIII Division 1 or 2, API 660 & TEMA as indicated in Mechanical Datasheets

Air Cooled Exchangers shall be designed in accordance with ASME Section VIII Division 1 or 2, API 661 as indicated in Mechanical Datasheets

Plate Heat Exchangers shall be designed in accordance with ASME Section VIII Division 1 or 2, API 662 Part 1 as indicated in Mechanical Datasheets

All static equipment shall be code stamped and National Board Registered

The latest edition at the time of equipment purchase shall be followed.

8.2 Standard Pressure Vessels by Vendor

Pressure vessels supplied as part of a Vendor's off-the-shelf (catalogue) standard design in package units may not comply with the requirements of this specification provided that all of the below mentioned requirements are satisfied:

a. The vessel is ASME Code stamped. For the application of alternate code, Contractor / Supplier shall obtain COMPANYs approval.

b. Full penetration welds joints are used for weld category A, B, C & D in accordance with ASME Section VIII Div.1 Sec UW-9.

c. The vessel is mechanically protected against overpressure conditions

8.3 Gas Cylinders and GRP Vessels

Gas Cylinders and GRP Vessels are not part of this specification, however guidelines for design code to be considered.

a. Gas cylinders (i.e. compressed, liquefied, dissolved gases, nitrogen gas bottles supplied as part of nitrogen cylinder package) shall be designed and supplied in accordance with ISO 9809 Parts 1 to 4. These four parts together specify the minimum requirements for the material, design, construction and workmanship, manufacturing processes, examination and testing at manufacture of refillable seamless steel gas cylinders for compressed, liquefied and dissolved gases.

b. GRP vessels, non-pressurized or pressurized, for use above ground shall be designed and supplied in accordance with BS EN 13121 Parts 1 to 4. These four Parts together define the responsibilities of the equipment SUPPLIER, the MATERIALS SUPPLIERS and the CONTRACTOR/COMPANY.

8.4 Design conditions shall be as specified on the Mechanical Data Sheet and may be related to all service conditions such as start-up, operation, depressurizing, shutdown and test conditions, etc. where appropriate, taking all normally expected fluctuations into account. Where abnormal (emergency) conditions can be predicted, their effects shall be evaluated, e.g. with respect to the equipment design lifetime.

8.5 The design shall be based on, but not limited to, the following: the design pressure/temperature, steam out condition, and liquid level conditions specified in the datasheets. In addition, influence of dead loads, live loads, external loads from piping and attachments, environmental loading (wind and seismic), operation loads, etc. shall also be considered. All conditions such as empty, erection, operating and hydraulic/pneumatic test conditions shall be analysed. The maximum operating fluid level and density of the fluid, full hydrostatic test load, service of the equipment i.e. utility, lethal, hydrocarbon, sour, cyclic shall be specified on the datasheet

(See table of combined applied loads in APPENDIX-1).

8.6 All process operating and design data required for the process and mechanical design of equipment and/or internals shall be in accordance with Process Datasheet.

8.7 The application of ASME Code cases to the design of equipment requires prior approval of the Company.

8.8 The CONTRACTOR/PROCESS LICENSOR shall specify all process design data required for the mechanical design of equipment and internals, including their locations, dimensions, materials and expected loads of internals.

8.9 When specified in datasheet, Computational Fluid Dynamics (CFD) analysis requirement for the equipment internals shall be in accordance with COMPANY Specification for Process Design Criteria.

8.10 The design of internals welded to the equipment shall take into consideration the effects of PWHT, hydro-test and loosening by vibration.

8.11 When aspects of design are outside the scope of the design code, supporting calculations shall be carried out by the SUPPLIER to prove the integrity of the design. The method of calculation and its acceptance criteria are subject to COMPANY'S approval. "Finite Element analysis" is an acceptable alternative.

8.12 Finite Element Analysis/Evaluation for specific equipment components as required in equipment datasheets shall be performed by the CONTRACTOR and SUPPLIER for validation of design.

8.13 The information contained in specified documents is the minimum requirement. Vendor shall increase the thickness of any pressure part or non-pressure part, if so required by mandatory code compliance during detailed design /fabrication at no extra expenditure to the CONTRACTOR/COMPANY.

8.14 All equipment shall be suitable for offshore/onshore installation, as applicable. For offshore / island installation, equipment shall be designed to withstand an outdoor marine offshore hostile environment, which is humid and salt laden with air borne fine dust/sand atmosphere.

8.15 Allowable Stress Values

Maximum allowable stresses for pressure and non-pressure containing parts welded to pressure parts shall be in accordance with the Code of Design & Construction at design temperature

When two sets of allowable stresses are provided for austenitic materials, the lower value shall be used for the design of flanges and the flanged extension of a tubesheet.

8.16 Design Life

Equipment be design life shall 30 years unless otherwise specified in the project document

8.17 Criticality Rating (CR)

A Criticality Rating (CR) shall be assigned to each equipment and shall be indicated on the Equipment Data Sheets/Drawings. The calculation method and the checking level requirements based on CR are given in the ADNOC Specifications for Criticality Rating System

The Criticality Rating (CR) listed on the Vessel Data Sheets/Drawings shall be used to determine factory inspection and testing requirements as outlined in ADNOC Specifications for Minimum Shop Inspection and Certification Requirement

8.18 Design Pressure

Design Pressure shall be established by Process as per Process Design Guidelines and specified in Process Datasheet.

The equipment shall be designed for Steam out condition when specified in the process datasheet. Steam out for internally coated or lined equipment is not permitted.

Components subjected to pressure on the both sides shall be designed to withstand design pressure on each side with atmospheric pressure or vacuum (if so designed) on the other side.

If specified in datasheet, Partitions in multi-compartment equipment shall be designed for the maximum differential pressure possible during normal operation, upset condition and hydrostatic test at the corresponding condition temperature, and shall also be designed to cater for start-up, depressurizing, shutdown and regeneration. In all cases, the design differential pressure shall be at least 1.1 times the maximum operating differential that can occur.

8.19 Maximum Allowable Working Pressure (MAWP)

Equipment MAWP, hot and corroded, shall be calculated by SUPPLIER using the full plate thickness as fabricated, less the corrosion allowance of the weakest part of the equipment. MAWP shall be calculated for equipment specified design conditions.

CONTRACTOR shall finalize with SUPPLIER the actual flange ratings for nozzles such that MAWP for equipment is not limited by nozzle flange rating. If design pressure is determined based on flange rating limitations in process datasheet, MAWP of the equipment shall be the same as the design pressure.

It is the CONTRACTOR'S responsibility to ensure uniformity of flange rating between equipment nozzle flange rating and the connected piping rating. All documents (e.g. P&ID, PMS, etc.) shall be updated and finalized accordingly.

MAWP shall be stamped on nameplate.

8.20 Design Temperature

Design Temperature shall be established by Process as per Process Design Guidelines and specified in Process Datasheet.

8.21 MDMT (Minimum Design Metal Temperature)

MDMT shall be based on ADNOC Specifications Process Design Criteria and shall be indicated in Process and mechanical datasheet.

Where depressurization temperature is lower than -46°C up to -105°C, lowest depressurizing temperature and corresponding pressure shall be indicated in the process datasheet based on the depressurisation calculation study report carried out by Contractor. In addition, depressurization pressure @ -46 °C shall also be indicated in process datasheet.

Contractor/Supplier shall ensure that primary membrane stresses at depressurization temperature of -46 °C shall not exceed allowable membrane stress as per ASME Section VIII.

8.22 Minimum Thickness for Pressure Vessel

CONTRACTOR/SUPPLIER shall verify the minimum thicknesses specified on the datasheet and increase where necessary to suit his calculations based on design data. In no case shall the minimum

fabricated thickness for shells, heads and skirt supports be less than that specified on datasheet or the following:

For Carbon and low alloy steel vessels: Minimum thickness shall be the greater of:

a. 5 mm excluding corrosion allowance, lining or cladding thickness as applicable

OR

b. 0.002 x inside diameter + 1.8 mm

For High alloy steel vessels the minimum thickness shall be 4 mm, and shall agree with ASME Section VIII, Division 1.

For clad or lined vessels the minimum thickness shall not include the cladding, lining or weld overlay thickness.

The thickness after forming of straight face of dished head shall not be less than the thickness of shell course to which it is attached.

When Vessel Data Sheets/Drawings are provided with nominal material thickness, these are minimum thickness including corrosion allowance and are based on CONTRACTOR'S design analysis. (The analysis considers all applicable loading to which the pressure vessel will be subjected.) Under no circumstances shall the SUPPLIER provide thickness less than the specified nominal material thickness. The SUPPLIER shall provide additional material thickness to the specified thickness of any component subject to thinning due to forming or scaling during fabrication.

The minimum thickness of welded internals shall be greater of the following unless otherwise specified:

- Thickness for strength + 2 x corrosion allowance.
- 3 mm + 2 x corrosion allowance.
- Design code minimum thickness.
- 5 mm for carbon steel and 4 mm for stainless steel with the exception that 3 mm may be used for stainless steel non-welded internals

The thickness of material used for any cladding or lining shall not be considered for computation of required wall thickness.

For nozzle reinforcement calculations, "the available area for reinforcement" as well as "the required area for reinforcement" shall consider the mill under-tolerance of 12.5% whenever pipe is envisaged.

Minimum thickness of any welded structural member shall not be less than 6 mm. Continuous fillet welds shall be used for structures, supports and fittings to be welded to the equipment.

8.23 Corrosion Allowance

Unless otherwise specified on data sheet and requirement in ADNOC Specifications Material Selection and Corrosion Control Philosophy document, the minimum corrosion allowance for vessels shall be as follows:

8.23.1. Carbon steel and low alloy Steel Vessels - 3mm

8.23.2. Alloy Clad Vessels - nominal cladding thickness as specified.

8.23.3. Gasket facing of flanges - 0 mm.

8.23.4. Carbon steel skirts if fireproofed - 1.6 mm under fireproofing.

8.23.5. Carbon steel skirt not fireproofed - 0 mm.

8.23.6. Carbon steel saddles for horizontal vessels - 0 mm.

8.23.7. 3mm of Corrosion allowance shall be applied for anchor bolts to the nominal diameter.

8.23.8. The corrosion allowance on removable internal parts, except for trays and stainless steel components, shall be ½ of the vessel corrosion allowance applied to all exposed surfaces, unless otherwise indicated on the vessel data sheets/drawings.

8.23.9. The corrosion allowance on non-removable internal parts shall be the same as the vessel corrosion allowance applied to all exposed surfaces, unless otherwise indicated on the vessel data sheets/drawings. For fillet and seal welds on internal attachments, the corrosion allowance shall be added to the required throat thickness.

8.23.10. A corrosion allowance is not required on removable or non-removable stainless steel internal parts.

8.23.11. The material selection, corrosion allowance, internal coating requirement and provision of anodes for the equipment and internals shall be based on equipment design life, material selection/corrosion study, and Company guideline document for material selection unless otherwise stated on the equipment datasheet. Where materials are not specified, CONTRACTOR / Supplier shall select suitable materials subject to approval by Purchaser.

8.23.12. Cast iron shall not be used for any part of the vessel.

8.23.13. When specified in datasheet, where liquid hold up is expected in nozzles, two (2) x corrosion allowance shall be considered for these nozzles

9 TECHNICAL REQUIREMENTS FOR PRESSURE EQUIPMENT

9.1 Discontinuous/Cyclic Processes

Discontinuous/Cyclic operation of equipment shall be indicated in the process datasheet.

Various pressure and temperature conditions shall be specified for each phase of equipment operation. Mixing of extreme conditions of pressure and temperature shall not be considered.

9.2 External Attachment

All load bearing welds attaching non-pressure retaining parts to pressure retaining parts shall be designed according to the same allowable stress basis for primary membrane tensile (compressive) and shear stresses as required for pressure retaining components of like material.

Supports shall be designed so that the metal temperature of the part of the support resting on concrete will not exceed 100°C.

For equipment with operating temperatures below ambient, this temperature shall be such that no condensation will occur under normal operating conditions. The mechanical design shall provide for insulation sealing, adequate surface protection and prevention of condensate collecting areas.

Lifting lugs or other attachments shall be designed to facilitate shipping, handling and field installation/lifting purposes. Lifting layout and Lifting calculation shall be prepared by SUPPLIER for applicable lifting/scenarios. Lifting lugs shall be designed to good engineering practice and shall be in accordance with Company “Standard Drawings”.

Lifting lugs/ trunnions on vertical vessels shall be designed for a single point lift. They shall be designed for horizontal lift from transporter to the final vertical position.

9.3 Vessel Supports

Unless otherwise stated on the vessel data sheet or COMPANY Standard drawing the height of legs shall be that required to provide a minimum clearance of 650 mm between the bottom of the vessel shell/head and the top of the finished ground level / platform deck level.

Leg supports shall not be used where either of the following criteria are applicable, unless otherwise stated on the vessel data sheet:

a. High vibration, shock, cyclic service or where the vessel is attached to reciprocating equipment.

b. The overall equipment height to outer diameter ratio exceeds 5:1.

c. Vessels greater than 1,500 mm outer diameter or 5,500 mm high.

d. The design temperature is not greater than 230 °C

Vessels may be supported by lugs if vessel is not in cryogenic service. In that case, the lugs shall be attached on pads that are of same material group as that of Vessel. Support lugs shall not be considered for vessels designed to ASME Section VIII, Div 2.

9.3.1 Saddle Supports

Below requirements are applicable for saddle supports. In case these contradict with any specified COMPANY Standard drawing requirements, same shall be discussed and mutually agreed.

Horizontal equipment shall be provided with two saddle supports with webs subtending at least 120° of the circumference, and minimum depth of web shall be 150 mm, (baseplate grade to equipment underside), unless otherwise stated on the datasheet. The vessel shall be fixed at one saddle and free to move in the longitudinal direction, due to thermal and pressure differentials, at the other saddle.

Slots shall be provided accordingly for the anchor bolts in sliding saddle to allow for thermal expansion of the vessel. The diameter of the bolt holes and width of the slot shall be 6 mm larger than the bolt diameter. The length of the slot shall be 2 x A x L x T minimum. Where:

A = Coefficient of thermal expansion of shell material, in/in °F

L = Length between saddle supports, measured to centreline of anchor bolts, inches

T = Greatest absolute value of: ambient temperature at installation (21°C) minus the maximum or minimum design shell temperature

Unless otherwise stated in the data sheet, the distance between centre lines of saddles shall be not less than 0.6 x L. where L is the length between head tangent lines.

Saddle support of vessel in a pit or buried in the ground shall designed for the buoyancy uplift effect due to pit flooding with water or ground water saturation

Stress on vessel shell due to saddle supports shall be checked in accordance with ASME Code Section VIII div 2 Para 4.15 or “L.P. Zick Method”. Check shall include saddles for horizontal vessels and temporary saddles used for hydrotest and transport of vertical vessels in horizontal position. (See paragraph 4.29).

The sliding saddle support shall be provided with anchor bolts and slots in the sliding saddle shall be oriented in the direction of thermal movement. The fixed saddle supports shall have holes of suitable size for the anchor bolts. In the case of saddle supports on equipment which are inclined, the stresses on shell shall be analysed by FEA.

Supports shall be designed so that the metal temperature of the part of the support resting on concrete will not exceed 100 °C

9.3.2 Low Friction sliding plate

When use of PTFE replacement is practically feasible, following shall be followed.

The saddle base plate on the sliding end shall be welded with a slide plate assembly. Slide plate size shall be larger than the saddle base plate size composed of metal backing plate (SS 316 3 mm thick) and a low friction coefficient material (PTFE or similar, 2.5 mm Thick) bonded on it. A similar slide plate assembly composed of metal backing plate thickness no less 20 mm bonded with low friction coefficient material (PTFE or similar) of the same order thickness shall be provided on the Structural Beam / deck beam (for Offshore) / concrete pedestal. The heights of fixed and sliding saddles shall be varied during manufacture to permit sliding plate assembly installations with centerline for the equipment remaining horizontal. Initially, composite thickness of both the sliding plates' assembly can be assumed to be 27 mm before detailed engineering is performed. The thickness/metallurgy/sizes of the of the low friction coefficient pad plates shall be revisited during detailed design activity when final dimensions will be computed. Necessary guiding arrangement shall be provided.

The value of co-efficient of friction of aged-sliding surface shall be obtained from the MANUFACTURER and same values shall be used in the design. But in no case co-efficient of friction used in design shall be less than 0.1.

Maximum bearing stress on the low friction coefficient material (PTFE or similar) shall be checked. The bearing stress on low friction coefficient material (PTFE) shall be within allowable limits for the equipment design temperature.

When PTFE replacement is not practically feasible, same arrangement of sliding plate assembly as stated above shall be provided without PTFE and co-efficient of friction used in design shall be 0.4

Alternate proposal to above when proposed by Manufacturer shall be subject to COMPANY approval

9.3.3 Vertical Equipment Supports and Anchor Bolts

Applicable Company standard drawing shall be followed for skirt support, leg support, bracket support and anchor bolts.

The thickness of support skirts shall be, as a minimum, either 6 mm for CS, 4mm for alloy steel or 1/3 of vessel wall thickness, whichever is higher. The support thickness shall be selected to meet all design requirement.

The skirt height shall be specified in the data sheet.

The outside diameter of vertical vessel skirts shall equal the outside diameter of the adjacent vessel shell for shell thickness up to 38 mm. For shell thickness over 38 mm, the mean diameters of the skirt and shell in the corroded condition shall align.

When required for tall skirts, skirts may be flared, however, the maximum flaring (half apex) angle shall not exceed 15°

Vertical vessel skirts shall be designed so the temperature of any supporting concrete will not exceed 100 °C or a lower temperature if specified in the vessel data sheet. For vertical vessels with operating

temperatures below ambient, condensation should not occur at the skirt base under normal operating conditions.

Base plate bearing stress, anchor bolt size, allowable design stresses and material shall be in accordance with ADNOC Specifications for Structural Design Basis. The minimum thread size of anchor bolts shall be ¾" (or M20). The SUPPLIER shall be responsible for design and sizing of the anchor bolts, slots and holes. Necessary design calculations and drawings showing the related details shall be part of his submittals.

For vessels classified in cyclic service or significant transient loading (e.g. rapid temperature change) the vessel shell and/or head area at the support attachment shall be checked for allowable stresses with an industry accepted and CONTRACTOR /COMPANY approved FEA Method. Allowable stress limits shall be in accordance with Part 5 of ASME Section VIII, Division 2.

All openings in the skirt shall be reinforced for 100% of the nominal plate thickness of skirt.

9.3.4 WELDS ON VESSEL SUPPORTS FOR OFFSHORE INSTALLATION

SUPPLIER to ensure that fillet weld sizes are adequate for the load conditions as per their design. The design of equipment supports and their welds to the deck plate shall disallow accumulation of moisture or water (due to rain, sea spray, condensation or wetting). The equipment supports shall be designed to transfer the shear, compression, and tensile forces to the supporting structure through welds by established practices and design methods. No strength increase will be permitted for environmental loading condition

9.4 Internals

CONTRACTOR shall specify all design data required for the mechanical design of internals, including their locations, dimensions, materials and expected loads of piping distributors, anti-swirl baffles, screens, filters, packing supports, etc.

All loads from each internal shall be carried through the supports for that internal to the equipment wall. Stacking of two or more internals on one support is not acceptable. The only exception to this condition shall be cartridge type process trays in small diameter towers where individual supports would prevent installation and removal of the trays.

Internal decks shall be designed for the most severe of:

a. Operating loads at design temperature.

b. Maintenance load of dead weight of the internal part plus 160 kg point load anywhere on deck.

9.5 Platform

Equipment shall be designed for operational access for inspection and maintenance of equipment and platforms shall be provided as required and shall meet requirement of ADNOC General Specification for Piping Basis of Design and Specification for Structural Steel Supply, Fabrication and Erection

9.6 Applied Loads and Analysis

Mechanical analysis shall be carried out on equipment to ensure suitability for lifting loads, transportation loads, thermal loads, cyclic and fatigue loads and loads combinations, as specified within later sections of this document.

The resultant combined stress due to effects of external primary mechanical loads and internal and/or external design pressure shall not exceed the stress limits sufficient for causing yield or buckling of pressure parts.

Design compliance to code requirements, structural strength requirements of various components and reinforcement for all openings, if already furnished, must be checked by the Vendor against the Fabrication Code and referenced documents. Where necessary, additional requirements shall be supplemented by the Vendor at no extra cost.

Standard details provided by Contractor/Supplier are not prohibited provided that the minimum details covered in Company “Standard Drawings for Static Equipment” are included in the Contractor/Supplier standard details.

9.6.1 Earthquake Load

Earthquake/ Seismic design requirements and parameters shall be as per ADNOC Specifications, Structural Design Basis. Earthquake design shall be in accordance with design code, Seismic Zone and Seismic Importance Factor as stated in ADNOC Specifications, Structural Design Basis Specification.

For equipment on offshore platforms, seismic design is not applicable.

9.6.2 Wind Load

Basic Wind Speed and other design requirements/ parameters shall be as per ADNOC Specifications, Structural Design Basis.

For vertical equipment, the maximum deflection at the top shall not exceed 1/200 of the total equipment height including skirt. For equipment with height to diameter ratio more than 10, vortex shedding shall be checked. The damping coefficient of 0.01 shall be used for this analysis for all conditions. To prevent vortex shedding, the following shall also be considered:

a. Piping and platforms shall be distributed around the circumference of the equipment, especially within the top third part of the equipment, to prevent vortices being formed.

b. If the above is not possible (e.g. only one overhead line and only rest platforms every 6 metres), and if the eddy shedding frequency is within 70% of the natural frequency of the equipment, three wind deflectors shall be installed with a width of one-tenth of the equipment diameter, evenly spaced in circumference and having a pitch of 5 times the diameter of the equipment, within the top third part of the equipment.

c. Alternatively, dynamic damping devices may be considered.

d. SUPPLIER shall check the static deflection and stresses induced under full wind loading in both, the operation and shutdown cases.

Vertical vessels subject to vortex oscillation shall have deflection limited to 1/400 and induced stress in shell, skirt, bolts and foundation limited to an acceptable level.

CONTRACTOR shall verify the following for the equipment which shows a possibility for wind induced vibrations (oscillatory motion) during operation as follows:

a. There will be no resonance.

b. The methodology given in ASME STS-1 Steel Stacks shall be used to determine the effective number of cycles for the design life in years. All possible modes of vibration shall be investigated to allow its design life.

Equipment shall also be checked for ovalling mode and stiffened if necessary.

The wind pressure shall be applied to the projected area on a vertical plane perpendicular to a horizontal wind from any direction and it shall be assumed to act on the equipment including ladders, platform and connected piping as per ADNOC specification for Structural Design Basis

The equipment shall have a shape factor of 0.7 (cylindrical).

The following guidelines shall be considered for estimation of force coefficient (Cf) when calculating Wind loads acting on equipment due to attached platform and / or Piping:

- For Horizontal Vessels, Cf shall be considered as 1.8 for Platform / Structural Supports.
- For Vertical Vessels, Cf shall be considered as 2.0 for Platform / Structural Supports at or below 1st level 1.6 for all members above.
- Force Co-efficient of Cf = 0.7 shall be considered for piping as minimum.
- Handrails and Ladders with Cage shall be considered for Cf = 2.0 or Projected area of 0.8 ft^2 / ft.

9.6.3 Weight of liquid contents load

The Contractor shall specify on the equipment datasheet the maximum operating liquid level and density of liquid as well as full hydrostatic test load for the equipment in the erected position.

9.6.4 Piping and Equipment Loads

This subsection defines the maximum permissible nozzle loads and moments due to thermal expansion and dead weight connected piping on the equipment. Components of static equipment attached to the nozzles shall be designed to withstand nozzle loads and moments due to these piping connections. Nozzle local load analysis shall be carried out accordingly. The loads and moments may act in any combination and direction concurrently with internal or external pressure. The piping loads and moments shall apply at maximum design conditions and considered to be acting at the intersection of nozzle and shell/head in corroded condition. Worst condition due to combination of

loads shall be considered during the design. The requirements for maximum permissible nozzle loads and moments shall be as per below Appendix for specific equipment

a. Appendix-2 Allowable Nozzle loads for Pressure Vessels
b. Appendix-3 Allowable Nozzle loads for Shell and Tube Heat Exchangers
c. Appendix-4 Allowable Nozzle loads for Plate and Frame Heat Exchangers
d. Appendix-5 Allowable Nozzle loads for Air Cooled Heat Exchangers

It is the Contractor's responsibility to ensure that the Vendor drawing shows the allowable loads (forces and moments acting simultaneously in all directions) for all 6 Degrees of Freedom. With regard to the radial load, calculations shall be made firstly with the force acting radial outwards in conjunction with the internal pressure and then with the force acting inwards. In the second instance, the internal pressure shall not be used to oppose the compressive stresses due to the force acting radial inwards; for this load condition, a null pressure condition is to be considered to exist.

9.6.5 Weight of Liquid Contents

The Contractor/Engineer shall specify on the equipment datasheet the maximum operating liquid level and density of liquid as well as full hydrostatic test load for the equipment in the erected position.

9.6.6 Blast Loads

Static equipment shall be designed to withstand the blast loads if specified in the equipment datasheets.

9.6.7 Lifting load

Lift weight shall include the weight of all components, such as trays, bundles, ladders, platforms, insulation, additional support/attachment, piping with insulation, etc. as applicable.

During lifting, special consideration shall be given to appurtenances lifted along with the equipment.

An impact factor of "2" shall be applied, as a minimum, to the lift weight of the equipment for the design of the lifting lugs/trunnions.

Lifting lugs shall be designed in accordance to Company standard and good engineering practices.

Local stresses in the equipment shell, head, skirt and base rings from lifting/tailing lugs and trunnions loads shall be determined using WRC Bulletins 297 or 537. Allowable stress values shall be as specified in local loading requirements in this design criteria.

Shear stresses for fillet welds on the lifting attachments to equipment shell or head shall not be greater than 0.55 times the Code-allowable stress at 38°C for the selected material.

Calculations detailing the equipment stress, the design of the lifting lugs or lifting trunnions and tailing lugs shall be provided for vertical equipment erected from the horizontal position.

Lifting stress calculations shall be performed for vertical equipment as follows:

a. Bending stresses in the equipment shell and skirt from the loadings imposed during the lift from horizontal to vertical position.

b. Calculated general primary membrane tensile stress shall not be greater than 80% of the material's specified minimum yield strength at 38°C.

c. Calculated compressive stress shall not be greater than 1.2 times the allowable compressive stress.

9.6.8 Transportation Loading

Equipment subject to transportation loadings shall be analyzed for the following conditions:

a. Bending between supports.

b. General primary membrane tensile stress.

c. Bending and compressive stress at supports and fixture attachment points.

Calculated general primary membrane tensile stress shall not be greater than 80% of the material's specified minimum yield strength at 38°C.

Shipping saddles shall be located approximately symmetrical each side of the vessel's Centre of Gravity. Shipping saddles and vessel shall be designed for the following forces acting simultaneously during transit, as a minimum:

- Longitudinal 0.6g
- Transverse 0.7g
- Vertical upwards 0.2g
- Vertical downwards 1.5g

Shipping saddles shall be located approximately symmetrical each side of the equipment's Centre of Gravity. Shipping saddles and equipment shall be designed for the transportation loads specified in this document. Calculations shall be provided for vertical equipment supported on temporary saddles during transportation in the horizontal position.

Shipping saddles strength shall be suitable for being supported at each end of saddle on 1-square meter, supports during shipment and storing for up to 6 months, without causing deflection of the saddle base and locally stressing the equipment above its design limits.

9.6.9 Local Loading

Contractor/Engineer/Manufacturer shall carryout local load analysis due to piping/ platform supports and other external loads and considering static and dynamic loads from any mounted equipment (e.g. Pump, mixer, or any other equipment) including lifting lugs, trunnions and internals support clips as applicable.

The loads imposed on the equipment are to be determined by the Contractor/Engineer and shall be specified on the datasheet. All analysis shall be done as per respective equipment specifications.

Nozzles with blinds and nozzles bolted with a valve, located in straight length of nozzle without any elbows in between (normally all process nozzles unless otherwise clarified by Company), shall be analysed for stresses due to internal pressure and pressure thrust load in accordance with WRC 368.

Calculations for local loads shall be carried out according to WRC 537 and WRC 297 or FEA.

All load bearing welds attaching non-pressure retaining parts to pressure retaining parts shall be designed according to the same allowable stress basis for primary membrane tensile (compressive) and shear stresses as required for pressure retaining components of like material.

9.6.10 Thermal Analysis

A thermal stress analysis is required for equipment if a thermal gradient along the circumferential or longitudinal axes, under steady state operating conditions, exceeds 65°C in a distance measured as the square root of R times T (D=$\sqrt{(RT)}$).

Were:

R: Radius of the equipment component under consideration. T: Thickness of the component under consideration.

R and T: Measured in the same units.

Thermal gradients may be reduced to within allowable limits permitted by equipment code with the provision of:

a. Thermal sleeves in pressure-retaining components.

b. Hot-box design at the skirt-to-vessel junction in skirt-supported equipment with design temperatures greater than 260°C.

The Contractor/Engineer is responsible for specifying the heat transfer coefficient to be used for all thermal stress analyses.

9.6.11 Cyclic Loading and Fatigue Analysis

The rules in ASME Section VIII Div.2, Paragraph 4.1.1.4 shall be used as a basis for establishing further action on fatigue analysis if a datasheet specifies equipment is in cyclic service.

Fatigue Evaluation is not mandatory if equipment, subjected to cyclic service, passes Fatigue Analysis Screening Method as defined in clause 5.5.2 of ASME Section VIII Div.2.

Should Fatigue Analysis become necessary, ASME Section VIII Div.2 shall be used to perform Fatigue Evaluation to ensure the number of cycles is acceptable for a 30-year operation life of the equipment.

The number of cycles shall include the number of start-ups, shutdowns, emergency shutdowns, and upset conditions.

9.6.12 Load Combinations

All Static Equipment shall be designed considering all loads and their possible combinations, including local buckling, bending, shear anticipated during transportation and erection. The equipment shall be designed for minimum pressure required by the service including partial/full vacuum.

Appendix-1 shall be followed for load combinations.

9.6.13 Hydrostatic Test Pressure

All equipment shall be designed for shop hydrostatic test in accordance with ASME Code Section VIII.

Need for future field hydrostatic test of equipment shall be evaluated and specified on the mechanical data sheet and accordingly equipment shall be designed for a future field hydrostatic test in the erected and corroded condition as per ASME Code Section VIII

Equipment Hydrostatic test Criteria:

a. Hoop stress in any part of the equipment shall not exceed 90% of the minimum yield strength of the material multiplied by the joint efficiency for Vessels designed to ASME Section VIII Div. 1. This allowable stress value shall be increased to 95% of the minimum yield strength of the material multiplied by the joint efficiency for equipment designed to ASME Section VIII Div. 2
b. The shop hydrostatic test pressure shall be calculated based on maximum allowable working pressure (MAWP). Integrally clad vessels shall be tested to a calculated test pressure based on base metal thickness (excluding cladding thickness). Non-clad vessels shall be tested to a calculated test pressure based on MAWP.
c. When required, 'Future hydro-test Pressure at Site shall be based upon calculated maximum allowable working pressure (MAWP).

9.7 Lethal Service Requirements

Lethal service definition shall be as per Process Design Criteria and as specified in the process datasheet. Lethal service requirements shall be as per the requirements specified in the respective Company equipment specifications.

9.8 Sour Service Requirements

For equipment operating under sour service as identified in the mechanical datasheet, materials and welding of all pressure parts, attachments welded to pressure parts and materials for internals shall be suitable for sour service applications and shall comply with the requirements specified in ADNOC General Specifications for Materials for Sour Services and NACE MR0175/ISO 15156 or NACE MR0103 requirement and the requirements applicable to the equipment type as specified in respective Company Equipment Specifications.

10 TECHNICAL REQUIREMENTS FOR HEAT EXCHANGERS (SHELL AND TUBE / AIR COOLED / PLATE AND FRAME)

10.1 Data sheets

When specifying a heat exchanger, the mechanical design code and equipment design standard shall be stated on the Data Sheets.

10.2 Design Rules

10.2.1. The principal mechanical design code shall be in accordance with applicable ASME Boiler and Pressure vessel Code Section VIII, Division 1 and/or ASME Boiler and Pressure vessel Code Section VIII, Division 2 whichever is referred.

10.2.2. The principal design standards shall be Tubular Exchanger Manufacturers Association (TEMA) in addition to ASME Section VIII. Shell and Tube Heat Exchanger shall confirm to ADNOC Specification for Shell and tube heat exchanger. The requirements of TEMA standard which are not amended shall be considered mandatory. Recommended Good Practice section of TEMA shall also be followed where applicable.

Shell and tube heat exchanger design shall also conform to latest edition of API STD 660 Petroleum, petrochemical and natural gas industries.

10.2.3 For Air Cooled Heat Exchanger, requirement in ADNOC Specification for Air Cooled Heat Exchanger and API 661 shall be followed in addition to ASME Section VIII

10.2.4 For Plate and Frame Heat Exchanger, requirement in respective Group COMPANY Specification for Plate and Frame Heat Exchanger (as applicable) and API 662 shall be followed in addition to ASME Section VIII

SECTION C

11 QUALITY ASSURANCE/QUALITY CONTROL

11.1. SUPPLIERS's Quality Management Systems shall comply with all the requirements of ISO 9001 "Quality Management Systems – Requirements" and ISO 9004 "Quality management -- Quality of an organization -- Guidance to achieve sustained success" with due regard to ISO 1901.

11.2. To ensure that all work is being performed consistently and accurately and to the requirements of the Project Specifications, CONTRACTOR shall ensure that the SUPPLIER shall have in effect, at all times, a QA program which clearly establishes the authorities and responsibilities of those responsible for the Quality System. Persons performing Quality functions shall have sufficient and well-defined authority to enforce Quality requirements that they initiate or identify and to recommend and provide solutions for Quality problems and thereafter verify the effectiveness of the corrective action.

11.3. Quality System and Quality Control requirements shall be identified and included in the CONTRACTOR's Purchase Documentation. Based on these requirements the SUPPLIER will develop a QA/QC program which shall be submitted to the CONTRACTOR for review and approval. The SUPPLIER's QA/QC program shall extend to SUB-CONTRACTORS and SUBSUPPLIERS. On request, the SUPPLIER shall provide objective evidence of QA/QC surveillance for all levels of the SUPPLIER activity.

11.4. COMPANY/ CONTRACTOR reserves the right to inspect materials and workmanship at all stages of manufacture and to witness any or all tests. The SUPPLIER, 30 days after award but prior to the pre-inspection meeting, shall provide the CONTRACTOR with a copy of its manufacturing Inspection and Test Plan and with copies of all related/ referenced procedures for review and approval. The Inspection and Test Plan will also be reviewed for inclusion of any mandatory COMPANY/ CONTRACTOR witness or hold points.

11.5. The Supplier shall make regular QA audits on all their Sub-Contractors compliance with ISO-9001. Details of these audits shall be made available to Company and Contractor. 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.

11.6. The Criticality Rating (CR) System outlined in respective Group COMPANY Specification shall be used by CONTRACTOR or CONTRACTOR's designee to develop the design checking levels and minimum requirements for shop inspection, testing and material certification given in respective Group COMPANY Specification.

12 GUARANTEE

For equipment such as Shell and Tube Heat exchangers, Air coolers, Plate Heat Exchangers, Filters, Coalescer and Vessels with internals, where Supplier must also meet process requirements, Supplier shall provide a process guarantee in addition to mechanical design guarantee

SECTION D

Standard Drawing:

Applicable Standard Drawings indicated in group COMPANY ANNEXURE shall be followed

SECTION E

APPENDIX: 1 TABLE OF LOAD COMBINATIONS FOR STATIC EQUIPMENT

Loads										
Design Case (8)	Thickness	Allowable Stress (1)	Temperature	Weight	Wind	Seismic (3)	Pressure	Local mechanical (7)	Thermal Piping	Vessel Appurtenance
Operating	Corroded	Per Code (13,14)	Design	X	X	X	X	X	X	Fully Dressed
Shop Hydrotest	Uncorroded	90% Y.S (1, 10)	Ambient (6)	X			X (4)	-	-	Bare Vessel
Lifting (12)	Uncorroded	90% Y.S (1, 10)	Ambient	X		-	-	-	-	Part or Fully Dressed
Erection (Empty)	Uncorroded	Per Code (13,14)	Ambient	X	X	-	-	-	-	As Lifting + Internals
Future Hydrotest	Corroded	90% Y.S (1, 10)	Ambient (6)	X	X (2)	-	X (5)	X	-	Fully Dressed
Shutdown (11)	Corroded	Per Code (13, 14)	Design	X	X	X	-	X	X	Fully Dressed

Load Combination Notes:

1. In tension only. Compressive stress to be per code at ambient temperature. For Vessels designed to Div. 2, allowable stress during hydrotest shall be based on 95% of the yield strength of specified governing material.
2. During hydrotest 50% of the wind load must be taken into account.
3. Seismic loads are not to be considered coincident with wind loads.
4. Shop hydrotest shall be based upon calculated maximum working allowable pressure (MAWP), and shall not be limited by nozzle reinforcement.
5. Future site hydrotest shall be based upon calculated maximum allowable working pressure (MAWP) and shall not be limited by nozzle reinforcement.
6. Test water temperature shall not be below the lower of
   I. the minimum design metal temperature or
   II. the minimum working temperature of the material allowed by the code.
7. Loads arising from the dead weight of piping (including contents) or other appurtenances attached to the equipment.
8. Other design cases may also require to be considered such as horizontal shop hydrotest of large/tall vessels, shipping and load out. During lifting, special consideration shall be given to column appurtenances lifted with the column.
9. All stresses are “general membrane” stresses.
10. Y.S. = Yield Stress at “ambient” temperature x Joint Efficiency.
11. Operating Liquid contents are not considered for Shutdown Condition.
12. Allow “Impact” factor of 2 for weight of equipment during lifting.
13. Equipment pressure part allowable stress shall be the equipment design stress increased by 1.2, unless otherwise stated on the equipment datasheet.
14. Equipment support skirts, legs and saddles allowable stress shall be the design stress increased by 1.3, unless otherwise stated on the equipment datasheet.

APPENDIX: 2 ALLOWABLE NOZZLE LOADS FOR PRESSURE VESSELS

1. This appendix defines maximum permissible nozzle loads applied by piping to pressure vessels, which shall be designed to withstand these loads. Piping reactions shall be within the limits indicated below

2. Simultaneous application of all 3 forces & 3 moments to be considered in the design. This is tabulated in Table A2-2.

P = Axial force	N
VL = Longitudinal force (for shell nozzles)	N
VC = Circumferential force (for shell nozzles)	N
FR = Resultant force (for head nozzles)	N
MT = Torsional moment	Nm
ML = Longitudinal moment (for shell nozzles)	Nm
MC = Circumferential moment (for shell nozzles)	Nm

MR Resultant moment (for head nozzles) Nm
Where P is applicable at the nozzle centreline and VL & VC are mutually perpendicular to P.

3. With regard to the axial load (P), calculations shall be made firstly with the force acting radial outwards in conjunction with the internal pressure and then with the force acting inwards. In the second instance, the internal pressure shall not be used to oppose the compressive stresses due to the force acting radial inwards; for this load condition a null pressure condition is to be considered to exist.

4. The tabulated forces and moments are applicable for vessels fabricated in carbon steel, austenitic stainless steel and duplex stainless steel materials. The tabulated values shall be reduced to 70% for titanium and 50% for copper-nickel piping systems.

5. Allowable loads as given are valid for materials up to 200°C. Above 200°C, a de-rating factor shall be applied as shown in Table A2:

Table A2-1 De-Rating Factor

Temperature °C	De-rating factor
200	1,00
250	0,92
300	0,83
350	0,75
400	0,67
450	0,58
500	0,50
Note: Interpolation between given values shall be permitted	

6. Each nozzle, including those designated “spare” but with the exception of manways and instrument nozzles shall be designed to withstand the forces and moments specified herein. The indicated loads are to be considered to act at the shell/head to nozzle intersection and to be true normal and tangential to the shell at that point. The effect on the shell/head shall be analysed per WRC 537(WRC 107) / WRC 297.

7. For vessels in Cyclic service or when WRC limits are exceeded, the analysis should be performed with an industry accepted and Contractor/Company approved Finite Element Method. Allowable stress limits shall be in accordance with Part 5 of ASME Section VIII, Division 2.

8. For Vessels which are designed for cyclic service, Nozzles shall be designed for a total number of minimum 7000 full temperature cycles over expected life times.

9. For tangential nozzles, the local load analysis on shell/head and nozzle neck shall be based on FEA.

10. If the application of the loadings, specified in this appendix, to a fully reinforced nozzle assembly, result in an increase in the shell or head thickness over that required for pressure and support loadings, then SUPPLIER is to advise the maximum loadings that can be applied to that reinforced nozzle assembly, without having to increase the shell or head thickness over that required for pressure and support loadings.

11. Contractor shall use actual nozzle forces & moments, in case nozzle sizes are larger than NPS 24.

Table A2-2 - Nozzle Allowable Forces and Moments

Pipe size (NPS)	ASME Class	P (N)	VL, VC (N)	FR (N)	MT (Nm)	ML, MC (Nm)	MR (Nm)
2	150	1000	1225	2000	350	250	495
	300	1000	1225	2000	350	250	495
	600	1485	1820	2975	470	335	665
	900	1485	1820	2975	470	335	665
	1500	1800	2205	3600	530	375	750
	2500	1800	2205	3600	530	375	750
3	150	1510	1850	3020	825	585	1170
	300	1510	1850	3020	825	585	1170
	600	2045	2500	4085	1070	755	1510
	900	2855	3500	5710	1380	975	1955
	1500	3705	4535	7405	1645	1160	2325
	2500	3705	4535	7405	1645	1160	2325
4	150	2150	2635	4300	1540	1090	2180
	300	2150	2635	4300	1540	1090	2180
	600	2985	3655	5940	2050	1450	2900
	900	3785	4640	7575	2485	1760	3515
	1500	5450	6720	10975	3260	2305	4610
	2500	5450	6720	10975	3260	2305	4610
6	150	3780	4630	7560	4075	2880	5765
	300	4600	5630	9200	4860	3440	6880
	600	5695	6975	11390	5865	4145	8295
	900	7250	8880	14505	7185	5080	10160
	1500	10595	12975	21185	9605	6795	13585
	2500	10740	13150	21475	9700	6860	13720
8	150	5690	6970	11380	7615	5385	10770
	300	6060	7425	12125	8075	5710	11420
	600	7100	8700	14205	9325	6595	12190
	900	12100	14820	24200	14785	10455	20910
	1500	16005	19600	32005	18415	13020	26045
	2500	17865	21880	35725	19950	14110	28215

Pipe size (NPS)	ASME Class	P (N)	VL, VC (N)	FR (N)	MT (Nm)	ML, MC (Nm)	MR (Nm)
10	150	8070	9880	16135	12755	9020	18040
	300	10910	13360	21820	16820	11895	23780
	600	12840	15730	25680	19460	13760	27520
	900	17795	21795	35595	25755	18210	36425
	1500	22920	28075	45845	31555	22315	44630
	2500	27150	33250	54300	35800	25315	50625
12	150	9880	12100	19755	17520	12390	24780
	300	10665	13065	21335	18830	13315	26630
	600	17665	21635	35330	29840	21100	42200
	900	25010	30630	50020	40250	28460	56925
	1500	32930	40330	65860	50160	35470	70940
	2500	37630	46085	75255	55395	39170	78340
14	150	10875	13320	21795	19870	14050	28100
	300	12640	15485	25285	22895	16200	32375
	600	21150	25905	42300	36635	25905	51810
	900	30050	36805	60095	49580	35060	70115
	1500	41830	51235	83665	64465	45585	91170
	2500	61185	74940	122370	83345	58935	117870
16	150	12470	15275	24940	24340	17215	34425
	300	16495	20200	32985	31700	22415	44830
	600	27225	33345	54445	50125	35445	70890
	900	38345	46965	76690	67405	47660	95325
	1500	52085	63795	104170	86180	60940	121880
	2500	74145	90815	148290	110400	78065	156130
18	150	14065	17230	28130	28665	20270	40535
	300	20855	25545	41715	41630	29435	58870
	600	34060	41715	68120	65210	46110	92220
	900	48650	59585	97295	88770	62770	125540
	1500	65855	80660	131710	113180	80030	160065
	2500	93195	114140	186385	144465	102155	204310
20	150	15050	18435	30105	35175	24875	49745
	300	21810	26715	43620	50020	35370	70745
	600	37005	45320	74005	81250	57455	114910
	900	52505	64305	105010	110055	77820	155645
	1500	67175	82275	134345	134465	95085	190165
	2500	99125	121405	198250	178055	125905	251810
22	150	15630	19140	31260	41790	29550	59105
	300	22110	27080	44215	58120	41100	82200
	600	38865	47600	77730	97650	69050	138100
	900	54795	67110	109585	131605	93060	186120
	1500	74895	91840	149970	169585	119915	239830
	2500	107155	131245	214310	218390	154425	308855
24	150	16670	20420	33340	50955	36030	72065
	300	22755	27870	45510	68475	48420	96840
	600	39400	48255	78800	113445	80220	160440
	900	57040	69865	114085	156400	110590	221180
	1500	76260	92405	152520	197660	139770	279535
	2500	108605	133390	217810	254550	179995	359990

APPENDIX-3 ALLOWABLE NOZZLE LOADS FOR SHELL & TUBE HEAT EXCHANGERS

1. Contractor shall use actual moments and forces in case nozzle sizes are larger than NPS 24.

2. The requirements and maximum permissible nozzle loads stipulated in Table 2 of API 660 shall be applicable to this design criteria, unless otherwise specified. Piping reactions shall be within the limits indicated below.

3. Stresses on interconnecting nozzles resulting from different thermal growth rates of stacked exchangers shall be included as superimposed loads in designing the nozzles.

4. Each nozzle, including those designated “spare” but with the exception of instrument nozzles shall be designed to withstand the forces and moments specified herein. The indicated loads are to be considered to act at the shell/head to nozzle intersection and to be true normal and tangential to the shell at that point. The effect on the shell/head shall be analysed per WRC 537(WRC 107) / WRC 297.

5. For vessels in Cyclic service or when WRC limits are exceeded, the analysis should be performed with an industry accepted and Contractor/Company approved Finite Element Method. Allowable stress limits shall be in accordance with Part 5 of ASME Section VIII, Division 2.

6. With regard to the radial load (FA), calculations shall be made firstly with the force acting radially outwards in conjunction with the internal pressure and then with the force acting inwards. In the second instance, the internal pressure shall not be used to oppose the compressive stresses due to the force acting radially inwards; for this load condition a null pressure condition is to be considered to exist.

7. If the application of the loadings, specified in this appendix, to a fully reinforced nozzle assembly, result in an increase in the shell or head thickness over that required for pressure and support loadings, then SUPPLIER is to advise the maximum loadings that can be applied to that reinforced nozzle assembly, without having to increase the shell or head thickness over that required for pressure and support loadings.

APPENDIX-4 ALLOWABLE NOZZLE LOADS FOR PLATE & FRAME HEAT EXCHANGERS

1. Components of Plate and frame heat exchanger shall be designed to withstand nozzle loads due to the connections. The requirements and maximum permissible nozzle loads stipulated in Table 1 of API 662 Part 1 shall be applicable to this design criteria, unless otherwise specified.
2. Nozzle loads that are greater than those listed in API 662, Part 1 shall be provided by the Contractor to Manufacturer/Supplier.
3. For offshore applications and pre-assembled modules, plate and frame heat exchangers shall be designed to withstand the nozzle loads and moments as per the severe service nozzle loading given in Table 2 of API 662 Part 1.
4. Purchaser/Contractor/Engineer/Manufacturer shall use actual moments and forces in all 6 degrees of freedom where nozzle sizes are larger than NPS 20.
5. FEA shall be used for the analysis.

APPENDIX-5 ALLOWABLE NOZZLE LOADS FOR AIR COOLED HEAT EXCHANGERS

1. Each nozzle, in its design corroded condition, shall withstand simultaneous application of twice the value of 3 moments and 3 forces defined in Table 4 of API 661.
2. Supplier shall conform to twice the value of nozzle loads and moments in excess of Table 4 of API 661 as provided by the Contractor to Manufacturer/Supplier.
3. The effect of these loads shall be incorporated into the design of header boxes, side frames, header box supports, and air cooled heat exchanger support structure.
4. FEA shall be used for the analysis.

ANNEXURE 1 - ADNOC GAS PROCESSING ADDITIONAL REFERENCES AND REQUIREMENTS

The following reference documents, form a part of this specification and are additional requirements to be followed for all Static Equipment to be procured/installed in ADNOC Gas Processing facilities. Latest Revision as time of contract shall be followed. CONTRACTOR shall advise COMPANY of any changes to Reference Documents after the EFFECTIVE DATE. CONTRACTOR shall comply with COMPANY instruction to comply with any changed Referenced Documents. CONTRACTOR shall advise of conflict among any Reference Documents and any technical specification, and COMPANY will determine which shall govern.

Specification

DGS 0000-001	Positive Material Identification Of Equipment And Piping
DGS 0000-002	Material for sour environment
DGS 0000-003	Minimum Shop Inspection and Certification Requirements
DGS 0000-004	Criticality Rating System
DGS 0570-001	Vessel Trays and Internals
DGS 6300-003	Welding and NDE of Pressure Vessels and Heat Exchangers
DGS 6600-010	Painting
DGS 6710-001	Preservation and Export Packing
DGS 6500-010	Hot Insulation for Piping and Equipment
DGS 6500-020	Cold Insulation for Piping and Equipment
DGS 6531-010	Fireproofing
DGS 6600-020	Internal Lining
DGS 0710-001	Air Cooled Heat Exchanger Amendments And Supplements To API Std. 661
DGS 0710-002	Air Cooled Heat Exchanger - Design Criteria
DGS 0660-001	Plate And Frame Heat Exchangers

STANDARD DRAWINGS

STD - 0400 - 101	Tolerances - Vertical Vessels
STD - 0400 - 102	Tolerances - Horizontal Vessels
STD - 0400 - 104	Manufacturer Nameplate
STD - 0400 - 106-1	Nameplates Mounting Bracket
STD - 0400 - 201	Manholes
STD - 0400 - 202	Projection of Nozzles
STD - 0400 - 203	Typical Details of Clad Plate Weld Joint Preparation
STD - 0400 - 204	Typical Detail of Weld Overlay and Alloy Clad Nozzles
STD - 0400 - 301	Skirts - Access Holes - Vents
STD - 0400 - 302	Support Legs for Vertical Vessels
STD - 0400 - 303	Support Saddle for Horizontal Vessels
STD - 0400 - 304	Anchor Chairs
STD - 0400 - 401	Flanges for Removable Internal Piping
STD - 0400 - 402	Internal Arrangement of Vessels
STD - 0400 - 403	Stilling Well for Displacement Type Level Instruments
STD - 0400 - 404	Typical Details of Demisters
STD - 0400 - 405	Typical Details of Demister Attachments
STD - 0400 - 406	Typical Details of Demister Supports
STD - 0400 - 501-1	Hot Insulation Supports (Vertical Vessels)
STD - 0400 - 501-2	Hot Insulation Supports (Hor. Vessels)
STD - 0400 - 502	Fire Proofing Supports
STD - 0400 - 503	Cold Insulation Supports
STD - 0400 - 505	Earth Connection

STD - 0400 - 506	Lifting Trunnions
STD - 0400 - 507	Lifting Lugs
STD - 0400 - 508	Tail Lugs
STD - 0400 - 509	Standard for Templates
STD - 0400 - 512	Schedule - AC/SS/CLAD
STD - 0400 - 905	Reinforcement Standard
STD-1881-002-001	Brackets for Platforms CI2-CU2-L<-1300
STD-1881-002-002	Brackets for Platforms CI1-CU1-L<-1300
STD-1881-002-003	Brackets for Platforms CI2-CU2 On Cold Vessels <-20 In Operation L<-1300
STD-1881-002-004	Brackets for Platforms CI1-CU1 On Cold Vessels <-20 In Operation L<-1300
STD-1881-002-005	CL3 Brackets for Platforms On Vessels
STD-1881-002-006	CL3 Brackets for Platforms On Cold Vessels <-20 In Operation
STD-1881-003-001	Davit With Tackle (PA) With Pulley (PL)
STD-1781-002-001	Anchor Bolts – Materials – Fabrication – Marking

ANNEXURE 2 - ADNOC REFINING ADDITIONAL REFERENCES AND REQUIREMENTS

The following reference documents, form a part of this specification and are additional requirements to be followed for all Static Equipment to be procured/installed in ADNOC REFINING facilities. Latest Revision as time of contract shall be followed. CONTRACTOR shall advise COMPANY of any changes to Reference Documents after the EFFECTIVE DATE. CONTRACTOR shall comply with COMPANY instruction to comply with any changed Referenced Documents. CONTRACTOR shall advise of conflict among any Reference Documents and any technical specification, and COMPANY will determine which shall govern.

Standard Specifications

Standard specifications listed below shall be used as referenced herein or on Project vessel Data Sheets/drawings:

DGS-MD-007	Requirements for Manufacturing Data Report for Pressure Vessels
DGS-MN-001	Insulation
DGS-MU-002	Preservation and Export Packing
DGS-MU-003	Specification for Spare Parts
DGS-MU-013	Criticality Rating System
DGS-MU-014	Minimum Shop Inspection and Certification Requirements
DGS-MW-001	Welding, NDE and Prevention of Brittle Fracture of Pressure Vessels and Heat Exchangers
DGS-MW-004	Materials and Fabrication Requirements for Carbon Steel Piping and Equipment in Severe Services
DGS-MW-005	Materials and Fabrication Requirements for Cr-Mo/Cr-Mo-V Steel Equipment for Higher Temperature, High Pressure Hydrogen Services
DGS-MW-006	Positive Materials Identification of Equipment and Piping
DGS-MX-001	Painting
DGS-MX-002	Galvanizing
DGS-MX-004	Internal Lining

Standard Drawings

Standard drawings listed below shall be used as referenced herein or on vessel Data Sheets/drawings:

STD-M01-001	Hot Insulation Support (Vertical Vessel)
STD-M01-002-01	Equipment Support Saddles Up To 3000 mm Diameter
STD-M01-002-02	Equipment Support Saddles Greater Than 3000mm Diameter
STD-M01-003	Anchor Bolt Ring Or Lugs And Base Plate Detail For Vertical Vessel
STD-M01-004	Skirts Cylindrical And Conical
STD-M01-005	Support Legs and Base Plate Details
STD-M01-006	Vortex Breakers
STD-M01-007	Bolting Non-Standard Flange With Unified Inch Screw Threads
STD-M01-008	Stilling Well For Displacement Type Level Instruments
STD-M01-009	Davit For ANSI Or BS Blind Flanges Nom Size 12"-24" And Classes 150-600 Incl.
STD-M01-010	Equipment Nozzles
STD-M01-011	Typical Details of Bush Lined, Overlay Welded and Clad Steel Nozzles
STD-M01-012	Hatch Way Covers
STD-M01-013	Nameplate With Bracket For Vessel And Heat Exchanger Equipment
STD-M01-014	Internal Ladder Rung Details
STD-M01-015	Typical Details of Demisters
STD-M01-016	Typical Details of Demister Attachments
STD-M01-017	Typical Details of Demister Supports

STD-M01-018	General Arrangement & Details Of Davit For Columns
STD-M01-019	Vessel Piping Support and Guide Details
STD-M01-020-01	Structural Steelwork Standards - Typical Vessel Ladder And Platform Details(vertical)
STD-M01-021-001	Tolerance - Vertical Vessels
STD-M01-021-02	Tolerance - Horizontal Vessels
STD-M01-022	Flange Bolt Hole Orientation
STD-M01-023	Tray Support Tolerance
STD-M01-024	Tray Tolerances
STD-M01-020-02	Structural Steelwork Standards - Typical Vessel Ladder And Platform Details(vertical)
STD-M01-020-03	Structural Steelwork Standards - Typical Vessel Ladder And Platform Details(vertical)
STD-M04-001	Obstruction Lights for Steel Stack
STD-M01-025	Earth Connection For Tanks, Vessels And Support Str
STD-M02-005	Warning Nameplate
STD-M01-026	Internal Pipe Support Details
STD-M01-027-01	Reflux Nozzle Details
STD-M01-027-02	Reflux Nozzle Details
STD-M01-027-03	Reflux Nozzle Details
STD-M01-028-01	Feed Nozzle Details
STD-M01-028-02	Feed Nozzle Details
STD-M01-028-03	Feed Nozzle Details
STD-M01-029	Flash Feed Details
STD-M01-030	Liquid Draw-off and Vapor Outlet Details
STD-M01-031	Side Reboiler Draw and Return Details
STD-M01-032	Tray Support Ring Details

ANNEXURE 3 - BOROUGE ADDITIONAL REFERENCES AND REQUIREMENTS

The following reference documents, form a part of this specification and are additional requirements to be followed for all Static Equipment to be procured/installed in Borouge facilities. Latest Revision as time of contract shall be followed. CONTRACTOR shall advise COMPANY of any changes to Reference Documents after the EFFECTIVE DATE. CONTRACTOR shall comply with COMPANY instruction to comply with any changed Referenced Documents. CONTRACTOR shall advise of conflict among any Reference Documents and any technical specification, and COMPANY will determine which shall govern.

Specifications

BGS-IU-001	Instrumentation and control
BGS-MD-006	Vessel Trays - General
BGS-MD-011	Pressure Vessels - Supplement for Low Temperature Services
BGS-MN-100	Thermal Hot Service Insulation
BGS-MU-002	Preservation and Export Packing
BGS-MU-013	Criticality Rating System
BGS-MU-014	Minimum Shop Inspection and Certification Requirements
BGS-MW-001	Welding, NDE and Prevention of Brittle Fracture of Pressure Vessels and Heat Exchangers
BGS-MW-004	Materials and Fabrication Requirements for Carbon Steel Piping and Equipment in Severe Services
BGS-MW-005	Materials and Fabrication Requirements for Cr-Mo Alloy Steel High Pressure Equipment
BGS-MW-006	Positive Materials Identification of Equipment and Piping
BGS-MX-001	Painting
BGS-MX-002	Galvanizing

Standard Drawing

BTD-MD-00011	Supports for Hot Insulation and Fireproofing
BTD-MD-00012	Saddle Details for Horizontal Vessels
BTD-MD-00013	Vertical Vessel Skirt Base Details
BTD-MD-00014	Skirts, Cylindrical and Conical
BTD-MD-00015	Support Legs and Base Plated Details
BTD-MD-00016	Vortex Breakers
BTD-MD-00017	Bolting for Non-Standard Flanges with Unified Inch Screw Threads
BTD-MD-00018	Stilling Well for Displacement-Type Level Instruments
BTD-MD-00019	Davit for ANSI or BS Flanges Nom. Size 12-24 Inch Inclusive Classes 150-600 Inclusive
BTD-MD-00020	Nozzles to Apparatus
BTD-MD-00022	Typical Details of Bush Lined, Overlay Welded and Clad Steel Nozzles
BTD-MD-00023	Internal Baffle Hatchway Cover Details
BTD-MD-00024	Nameplate with Bracket for Vessel and Heat Exchange Equipment
BTD-MD-00025	Internal Ladder Rung Details
BTD-MD-00026	Typical Details of Demisters
BTD-MD-00027	Typical Details of Demister Attachments
BTD-MD-00028	Typical Details of Demister Supports
BTD-MD-00029	Davit for Column, General Arrangement & Typical Details
BTD-MD-00030	Vessel Piping Support and Guide Details
BTD-MD-00031	Typical Vessel Ladder and Platforms, Sheet 1
BTD-MD-00032	Vessel Tolerances
BTD-MD-00033	Flange Bolt Hole Orientation
BTD-MD-00034	Tray Support Tolerances

BTD-MD-00035	Tray Tolerances
BTD-MD-00036	Typical Vessel Ladders and Platform Details, Sheet 2
BTD-MD-00037	Typical Vessel Ladders and Platform Details, Sheet 3
BTD-MD-00038	Obstruction Lights for Steel Stack
BTD-MD-00040	Earthing Clips for Tanks, Vessels and Supporting Structures
BTD-MD-00041	Warning Nameplate
BTD-MD-00042	Internal Pipe Support Details
BTD-MD-00043	Reflux Nozzle Details, Sheet 1
BTD-MD-00044	Reflux Nozzle Details, Sheet 2
BTD-MD-00045	Reflux Nozzle Details, Sheet 3
BTD-MD-00046	Feed Nozzle Details, Sheet 1
BTD-MD-00047	Feed Nozzle Details, Sheet 2
BTD-MD-00048	Feed Nozzle Details, Sheet 3
BTD-MD-00049	Flash Feed Details
BTD-MD-00050	Liquid Drawoff and Vapor Outlet Details
BTD-MD-00051	Side Reboiler Draw and Return Details
BTD-MD-00052	Tray Support Ring Details

ANNEXURE 4 - ADNOC ONSHORE ADDITIONAL REFERENCES AND REQUIREMENTS

The following reference documents, form a part of this specification and are additional requirements to be followed for all Static Equipment to be procured/installed in ADNOC ONSHORE facilities. Latest Revision as time of contract shall be followed. CONTRACTOR shall advise COMPANY of any changes to Reference Documents after the EFFECTIVE DATE. CONTRACTOR shall comply with COMPANY instruction to comply with any changed Referenced Documents. CONTRACTOR shall advise of conflict among any Reference Documents and any technical specification, and COMPANY will determine which shall govern.

COMPANY PROCEDURES, STANDARDS AND AMENDMENTS TO SHELL DEP

EP 30.99.90.0024	Preparation of Supplier's/Vendor's Engineering Drawings and Documents.
EM 30.99.95.0006	Guidelines for Submission of Electronic Documentation.
EP 30.99.90.0001	Drawing Design and Numbering Systems.
EP 30.99.00.0001	Engineering Specification for Tag Plates for Field & Indoor Equipment
EP 30.99.90.0002	Procedure for project drawing as built mark-up and master drawing
ES 30.99.00.0102	Corrosion control and Material selection Philosophy
ES 30.99.37.0013	Specification for Painting & Coating of New Equipment
EP 30.99.97.0006.1	Project Quality System Requirements

Shell DEP's Standards

31.22.00.30-Gen February 2017	Equipment Criticality for use in pressure vessel design

ANNEXURE 5 – FERTIL ADDITIONAL REFERENCES AND REQUIREMENTS

The following reference documents, form a part of this specification and are additional requirements to be followed for all Static Equipment to be procured/installed in FERTIL facilities. Latest Revision as time of contract shall be followed. CONTRACTOR shall advise COMPANY of any changes to Reference Documents after the EFFECTIVE DATE. CONTRACTOR shall comply with COMPANY instruction to comply with any changed Referenced Documents. CONTRACTOR shall advise of conflict among any Reference Documents and any technical specification, and COMPANY will determine which shall govern.

Standard Specifications
Standard specifications listed below shall be used as referenced herein or on Project vessel Data Sheets/drawings:

F2-00-MS-SPC-1001	Painting
F2-00-MS-SPC-1002	Insulation
F2-00-MS-SPC-1004	Supports For Pressure Vessel
F2-00-MS-SPC-1005	Hydrogen and/or Sour Gas Service
F2-00-MS-SPC-1006	Surface Treatment of Austenitic SS after Welding
F2-00-MS-SPC-1007	Non-destructive Testing (NDT)
F2-00-MS-SPC-1010	Preservation
F2-00-MS-SPC-1010	Material Identification Programme
F2-00-MS-SPC-1010	Welding
F2-00-PI -SPC- 0001	Piping Material Specification

Standard Drawings
Standard drawings listed below shall be used as referenced herein or on vessel Data Sheets/drawings:

F2-00-ST-SDG-0001	Standard Drawing General Notes(1/2)
F2-00-ST-SDG-0002	Standard Drawing General Notes(2/2)
F2-00-ST-SDG-0008	Standard Drawing Anchor Bolts Detail
F2-00-ST-SDG-0009	Standard Drawing Base Plate - Hinge Support
F2-00-ST-SDG-0021	Standard Drawing Steel Stair Detail
F2-00-ST-SDG-0022	Standard Drawing Ladders & Safety Gate Detail
F2-00-ST-SDG-0023	Standard Drawing Handrail Detail
F2-00-ST-SDG-0024	Standard Drawing Grating, Floor Plates & Joist Detail

ANNEXURE 6 - ADNOC OFFSHORE ADDITIONAL REFERENCES AND REQUIREMENTS

The following reference documents, form a part of this specification and are additional requirements to be followed for all Static Equipment to be procured/installed in ADNOC Offshore facilities. Latest Revision as time of contract shall be followed. CONTRACTOR shall advise COMPANY of any changes to Reference Documents after the EFFECTIVE DATE. CONTRACTOR shall comply with COMPANY instruction to comply with any changed Referenced Documents. CONTRACTOR shall advise of conflict among any Reference Documents and any technical specification, and COMPANY will determine which shall govern.

Technical Specifications

Designation	Title
A0-ENG-N-SL-001	Status List for ADNOC Offshore Technical Standard Documents
A0-ENG-V-SP-002	Specification for Plate and Frame Heat Exchangers
A0-ENG-V-SP-006	Specification for Pig Launchers and Receivers
A0-ENG-V-SP-008	Specification for Air Cooled Heat Exchangers
A0-ENG-V-STD-001	Standard Details for Pressure Vessels, Heat Exchangers and Tanks
A0-ENG-S-SP-004	Specification for Structural Design of Equipment Skids
A0-ENG-P-SP-001	Specification for Small Bore Piping Connections
A0-IG-C-SP-008	Cathodic Protection Specification for Above Ground Storage Tank Bottom External
A0-IG-C-SP-010	Cathodic Protection Specification for Tanks and Vessels Internal Surfaces
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 & Existing Constructions of Offshore and Onshore Structures
STD-00, Part-1	Measurement Units
A0-IG-J-CP-001	Inspection & Testing Requirements for New Equipment & Materials in Manufacture
A0-IG-F-CP-001	Code of Practice for Inspection and Testing of Plant In Service
GDL-009	Project Deliverables
GDL-012	Material Selection
GDL-040	Concession Request
PRO 110 Part 2	Procedure for Pressure Testing Part 2: Pressure Vessels
Z0000-PB-GEN-N-121	HSE Critical Equipment & Systems Management System (HSECES MS)
SP-1000	Materials for sour services
SP-1002	Preservation of new Materials & Equipment
A0-Q-PQ-SP-002	Requirements for Contractors Quality Systems on Major Projects
SP-1021	Water Quality for Hydrostatic Test
A0-IG-P-SP-006	Thermal Insulation (Hot & Cold) of Piping and Equipment
A0-IG-P-SP-007	Specification for Passive Fire Protection
A0-ENG-S-STD-001	Design Criteria for Fixed Offshore Steel Structure
A0-Q-PQ-SP-001	Quality Control Personnel for Fabrication and Construction
A0-IG-W-SP-002	Pre and Post Weld Heat Treatment of Ferrous Materials
A0-ENG-P-SP-004	Specification For Stress Analysis
A0-IG-Z-SP-001	Integrity Requirements for Baseline Survey of New Equipment in Projects
SP-1131	Specification for Piping Classification
SP-1149	Sour Services Application for Offshore and Onshore Facilities
STD-103	Approval of Welding Procedures and Welder Performance
A0-ENG-P-STD-001	Standard for Flanges
A0-ENG-P-STD-006	Bolting for Piping

Designation	Title
A0-ENG-P-STD-007	Standard for Gasket
A0-ENG-P-STD-002	Piping Fittings
STR-001	Maintenance Strategy
Z0000-GL-GEN-N-011-062	Noise
Z0-TS-P-05010	Piping material specification
Z0-TS-Y-03010	Thermal Insulation-Hot Services for Piping and Equipment
Z0-TS-Y-03020	Thermal Insulation-Cold Services for Piping & Equipment
Z0-TS-Z-02010	Vendor Document and Data Requirements: Pressure Vessels and Heat Exchangers for Mechanical Equipment Packages