

Gujarat State petroleum Corporation Ltd.

FLARE GAS MONETISATION PROJECT QPS-SE#3

MECHANICAL DESIGN BASIS

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1. INTRODUCTION

The scope of this document is to provide the Mechanical design basis for Flare Gas monetization Project: QPS – SE #3.

1.1. Scope of Document

This document describes the mechanical basis of design and codes & standards that will be used for the design of various static, rotating and package equipment covered under “Flare Gas monetization Project: QPS-SE#3”, herein after referred to as “Project”.

2. CODES AND STANDARDS

The following international codes and standards will be referred for the design and engineering services. All codes & standards referred shall be latest edition.

2.1. International Codes & Standards

Codes & Standards	Description
ASME Sec. II	Material Specifications and Properties Parts A, B, C & D
ASME Sec. VIII Div.1	Rules for Construction of Pressure Vessels.
ASME SEC V	Non-Destructive Examination
ASME SEC IX	Qualification standard for Welding, Brazing and fusing procedures; Welders, brazers and welding, brazing and fusing operators
ASME B31.4	Pipeline Transportation System for Liquid & Slurries
ASME B31.3	Process Piping
ASME B16.5	Pipe Flanges and Flanged Fittings NPS ½ through 24
API 610	Centrifugal Pumps for Petroleum, Heavy Duty Chemical and Gas Industry Services
API 618	Reciprocating compressor
API 619	Rotary-Type Positive-Displacement Compressors for Petroleum, Petrochemical and Natural Gas Industries

Codes & Standards	Description
API 675	Positive Displacement Pumps—Controlled Volume for Petroleum, Chemical, and Gas Industry Services
API 676	Positive Displacement Pumps- Rotary
API 682	Pumps – Shaft Sealing for Centrifugal and Rotary Pumps
API MPMS Chapter 22.6	Testing Protocol for Gas Chromatographs
API RP 521	Pressure-Relieving and Depressurizing Systems
API RP 686	Recommended Practice for Machinery Installation and Installation Design
ISO 1940	Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state - Part 1: Specification and verification of balance tolerances
NFPA 20	Standard for the Installation of Stationary Pumps for Fire Protection
OISD-STD-118	Layouts for Oil and Gas Installations
OISD-STD-119	Selection, Operation and Maintenance of Pumps
OISD-RP-123	Selection, Operation and Maintenance of rotary equipment components
OISD-STD-125	Inspection and Maintenance of Mechanical Seals

3. DEFINITIONS / ABBREVIATIONS

3.1. Definitions

Nomenclature	Description
COMPANY	M/s Gujarat State Petroleum Corporation Ltd.
ENGINEERING CONSULTANT	Gujarat Energy Research and Management Institute
VENDOR	Shall mean the party, who manufactures or supplies the equipment and services specified
PROJECT	Flare Gas Monetization Project: QPS-SE#3

3.2. Abbreviations

Abbreviations	Description
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
BOPD	Barrels of Oil per Day
CA	Corrosion Allowance
FAT	Factory Acceptance Test
FEED	Front End Engineering Design
IS	Bureau of Indian Standards
MMSCFD	Million Standard Cubic Feet per Day
NACE	National Association of Corrosion Engineers
NFPA	National Fire Protection Association
OISD	Oil Industry Safety Directorate
RFQ	Request for Quotation

4. REFERENCE DOCUMENTS

Doc. No.	Description
GERMI/BDP/GSPCL/02/2 5-26	Feasibility and Basic design Report

5. ORDER OF PRECEDENCE

Normally the project specific documentation (specifications, drawings and datasheets) are in compliance with the regulations, standards and codes.

- a) Government Regulations and Statutory Requirements
- b) Project specifications and data sheets
- c) Project Design Basis
- d) Indian and International codes and standards
- e) Company Standards/Specifications /drawings

In case of contradiction between the above listed codes & specifications, the more stringent shall govern.

6. UNITS OF MEASUREMENTS

All unit of measurement shall be as per Feasibility and Basic design Report and shall be used in this PROJECT for all data sheets, calculations and drawings

All Dimensions & weights measurement shall be expressed in international unit system.

Quantity or Variable	Metric Units	Imperial / Field Units
Capacity	m ³	BBL
Liquid Flow by Volume	m ³ /hr or L/H	BOPD/BLPD
Gas Flow by Volume	kgmol/h or Nm ³ /h	MMSCFD
Liquid / Gas Flow by Weight	kg/h or kg/s	
Length	mm or m	
Pipe Diameter	mm N.B.	
Surface Area	m ²	
Volume	m ³	BBL
Pressure	kPag, barg or mmWG	
Design Pressure	kPag, barg or mmWG	
Differential Pressure	kPa, bar or mmWG	
Pressure Losses	kPa/km or bar/km	
Power	kW	
Heat Duty	kcal/h or kJ/h or kW or MW	
Temperature	°C , °K	
Viscosity	cP or Pa.s (Pascal-second)	

Standard conditions of temperature and pressure is defined as temperature of 15.56 °C (60 °F) and an absolute pressure of 101.325 kPa (14.696 psia) and Normal conditions of temperature and pressure is defined as temperature of 0 °C (32 °F) and an absolute pressure of 101.325 kPa (14.696 psia) for volume calculations of gas.

7. EQUIPMENT DESIGN BASIS

All materials & equipment used under this project shall be new and unused.

The minimum design requirements shall be considered as indicated in individual equipment or package specifications/ data sheets.

All materials shall conform to ASME Sec. II / ASTM/ IS Standards. Selection of the equipment shall be based on the following considerations:

- I. Suitability for the specified duty condition.
- II. Standard Models under vendor's regular range of manufacture.
- III. Proven Track Record in similar service and duty conditions.
- IV. Ease of handling, transportation, installation, maintenance etc.

The following type of Mechanical Equipment are envisaged for the Project:

- I. Reciprocating compressor
- II. Membrane type Gas dehydration Unit
- III. Centrifugal Pumps
- IV. Controlled Volume Pumps (part of Chemical Dosing package)
- V. Inlet KOD Vessel
- VI. Close Blowdown Vessel
- VII. Instrument Air Package
- VIII. Odorant Dosing Package
- IX. Any other type of equipment as required by Company for the project

Skid mounted Equipment shall be provided with a lifting frame or spreader bar complete with slings and shackles to enable a single point lift. The lifting frame and spreader bar shall be permanently marked with safe working load and shall be tested and certified by a competent authority.

As far as possible, skid mounted equipment ready to be installed as a single unit and requiring minimum field activities shall be preferred.

VENDOR has the overall responsibility for the supply of the Equipment / Package. This overall responsibility shall include, but not limited to co-ordination for all the work performed by VENDOR as well as for the work performed by their sub-vendors, taking unit responsibility for the complete equipment / package.

Equipment noise level (Driver + Driven equipment train + auxiliaries) shall not exceed 85 dBA when measured at 1.0m distance from the equipment skid and 1.5m above grade or man-way platform in any direction.

Shop & field painting for equipment and packages shall be in accordance with applicable standards and specification.

Insulation for equipment and packages shall be in accordance with applicable standards and specification.

Electrical, C&A, Piping etc. associated with mechanical equipment and packages shall comply with respective RFQ/ Specification requirements.

The Contractor shall carry out design and fabrication of skid mounted units as per latest codes & standards. To the extent possible, Skid Integration shall be ensured to reduce piping, cabling, and panel count. Suggested skid integration is to combine odorization, USM and GC into a single instrumentation skid likewise, for GG and synchronization panel etc.

In addition to above, a smart PLC Architecture comprising of a shared PLC across compressor, GDU, and odorization, to enables centralized control and reduced panel costs shall be preferred.

Unless otherwise specified, all equipment shall be sourced from approved vendor list as applicable for the Project. The static and rotating equipment covered under this project are listed as below

7.1. Pumps

7.1.1 Centrifugal Pumps

Design of Centrifugal pumps shall confirm to latest edition of API / ISO / ANSI / ASME requirements as applicable.

Unless otherwise specified, all pumps shall be Electric motor driven. Pump duty points shall be as per process requirement and datasheet.

The motor nameplate rating for the pumps shall be as per API 610 but not less than maximum BKW at any point on pump performance curve from shut

off to end of curve for rated impeller.

The available NPSH shall be at least 1m of liquid column higher than the required NPSH provided by the pump manufacturer.

Pumps with impeller inducers shall be considered only after prior approval from company. Suction Flange rating shall be same as discharge Flange.

All metallic components, including those of seal, piping and instruments being exposed to the pumping liquids shall be selected suitably or as specified in individual Package specifications.

Pump shall be provided with mechanical seal. Unless otherwise specified, mechanical seal and seal system shall conform to API 682-Shaft sealing systems for centrifugal and rotary pumps. For seals not complying with dimensional requirement of API 682 shall be subject to approval.

Coupling shall be Flexi-metallic spacer type with service factor not less than 1.5 over the driver rating.

7.1.2 Controlled Volume Pumps

Design of pump shall confirm to API 675, Latest edition.

Pump duty points shall be as per process requirement and datasheet.

Positive displacement, reciprocating pump with Hydraulic driven diaphragm type liquid end are acceptable.

Each pump shall be Diaphragm type.

Pulsation suppression devices shall be provided at the discharge manifold of the pumps. However, when necessary, pulsation dampener shall be provided at suction to maintain adequate margin between NPSHA and NPSHR. Dampener shall be sized to ensure control of pulsation (Residual Pulsation <5%) in the entire range of operation of pump. Volume bottle type pulsation dampener shall be preferred, however if Nitrogen pre- charged piston type/ bladder type dampener is provided, Vendor shall supply the Nitrogen pressure regulator along with the gas charging kit. There shall be an in-built pressure gauge in the dampener to indicate the nitrogen charging pressure.

7.2. Process Vessel

Vessel design, materials, fabrication, inspection, testing and stamping shall be as per ASME Section VIII, Div.1 and Company specification for Pressure Vessels CAIRN-TSG- M-SP-0001. ASME U Stamp Certification shall be as per vessel data sheet. All pressure vessels shall be designed for Full Vacuum conditions if specified in the datasheet.

Mechanical Calculations of pressure vessels shall be performed using latest edition of Company approved software and shall be submitted to Company for approval.

Pressure vessels shall be provided with internal lining as per the requirements specified in data sheet.

Cathodic protection system shall be provided in accordance with the requirements specified in the datasheet. External Painting shall be as per requirements specified in the datasheet.

Removable internals of all pressure vessels shall be removable thru 24” man-way provided on the vessels and sufficient number of man-way shall be provided for all vessels for easy maintenance and inspection and removal of internals.

Insulated vessels have to be provided with inspection ports.

7.3. Package Equipment

7.3.1 Wet gas Reciprocating Compressor

Compressor shall be non-lubricated, reciprocating type. Compressor and shall conform to Company Specification for wet gas reciprocating compressor package.

Compressor shall be electric motor driven, 415 V, 3-phase, 50 Hz, Induction Motor (VFD), with dV/dt or sine wave filter. VFD start/stop, speed control via PLC or HMI.

Each Compressor package should have its own independent suction

knockout drum, intercoolers, after cooler, outlet scrubber and an integrated auto-drain system etc. so that each compressor package is independent and does not have common facilities with other compressor package at the same installation.

Each compressor package shall be provided with suction and discharge shutdown valves for automatic shutdown and blow down of the package as and when required.

Safety, relief and blow down system shall be designed in accordance to API 520 & API 521.

Battery limit of compressor vendor is from upstream flange of suction shutdown valve to downstream flange of discharge shutdown valve.

Each compressor shall be Skid mounted, with its local PLC. Suitable control system to divert gas to plant blow down system, based on safety and process requirement shall be provided.

Fixed Gas detection system (DGMS) approved for compressors as per OISD standard 116 & 189 (minimum two nos. of sensors for each compressor) shall be provided.

7.3.2 Membrane type Gas dehydration Unit

The membrane type GDU Package shall be self-contained with accessories as required.

The package / Equipment data sheet shall be referred for the operating and design condition.

Following design criteria needs to be looked into

- Life of the Plant: Minimum 20 years
- Membrane Type: suggested type is Hollow fiber (e.g., PEEK-Sep™) which offers high selectivity and compact footprint. However, vendor may suggest other type of membrane system which meets the intended process performance of providing export quality gas with less than 0°C of HC as well as water dew point at 7 barg of line pressure and at less than 55°C temperature.
- Typically, 3–5% of feed gas in permeate gets lost; This needs to be minimized with recycle or fuel use, as per vendor's recommendation
- Membrane performance at operating temperature shall be ensured,

without ant degradation in membrane quality.

The GDU package shall be provided with suction and discharge shutdown valves for automatic shutdown and blow down of the package as and when required. Safety, relief and blow down system shall be designed in accordance to API 520 & API 521. Dual PSVs (1 operating + 1 standby) shall be provided on all vessels which are under continuous operation and their standby is not available.

The GDU shall conform to applicable standards and Specification for membrane type gas dehydration unit package.

7.3.3 Instrument Air Package

The Instrument and Utility Air Package shall be self-contained with accessories as required.

The package / Equipment data sheet shall be referred for the operating and design condition.

Air Compressor shall be electric motor driven, oil flooded rotary screw type. Compressor shall conform to Company Specification for Instrument Air Package,

Compressor Inter coolers, after coolers and lube oil cooler shall be air cooled unless otherwise specified in the data sheet.

Instrument air receiver shall be sized with the holdup time of 30 minutes between the pressure level of 11 to 6.5 kg/cm²g to supply the instrument air to the consumers for safe shutdown.

Sound attenuating housing shall be considered where noise levels exceed 85 dBA at 1 m from the edge of the skid.

All pressure Vessel (including absorber and Air receivers) for this package shall be designed, fabricated, inspected and tested as per ASME Section VIII Div.1 and vendor's specification.

7.3.4 Chemical Dosing Package

Chemical injection package data sheet shall be referred for the operating and design condition and chemical dosing rates.

The Package shall be supplied as skid mounted unit with complete Piping, electricals, instrumentation, etc., within the skid limits as indicated in the respective P&ID's

Pump shall be Controlled Volume Positive Displacement Double diaphragm stroke type and shall comply with API 675 and Specification for Positive Displacement Pumps- Controlled Volume.

Dosing pumps shall be provided with manual stroke adjustment as default.

Unless otherwise specified all dosing pumps shall be electric motor driven.

Discharge pulsation suppression device shall be provided for each chemical injection pump. The pulsation suppression devices shall be designed, fabricated and tested in accordance with ASME VIII Div. 1.

Calibration pot shall be provided for each chemical injection pump.

Chemical storage tank shall be designed according to ASME Sec. VIII Div. 1, BS 4994 or Good Engineering Practice as specified in Equipment datasheet.

Package skid shall be modular construction. Common base plate for pump, motor, dampeners designed for single lift.

Pump shall be provided with full flow relief valves at discharge, upstream of any pump's isolation valve.

The elastomeric diaphragm shall be resistant to the product being pumped. The diaphragm shall be field replaceable. Any special tools required for diaphragm replacement shall be supplied with the pulsation suppression device.

The Package Skid shall be provided with cover to have protection from sun and rain. Alternatively, the package shall be located in a shed.

8. DESIGN LIFE

The new equipment shall have a design life of twenty (20) years. Selection of equipment and accessories shall be based on minimum maintenance requirements without the need of specialized maintenance operating staff.

9. SOFTWARES

The following software's shall be used for the process design of this project:

Description	Software
PFD and UFD	AUTOCAD
P&IDs	AUTOCAD
Project documents	Microsoft Office
Equipment, PSVs, and line sizing	Relevant codes and standards
Process Simulation	Aspen HYSYS

10. EQUIPMENT SPARE PARTS & SPECIAL TOOLS

Equipment supplier shall provide all mandatory spares, Start-up & commissioning spares and List of 2 years normal operation spares as specified in the RFQ.

Special tools / tackles shall be procured and supplied along with the main equipment / package as per manufacturer's recommendations. One set of special tools / tackles shall be supplied for each item tag no. i.e. one common set for all working and standby units of an item tag.