Islamic Emirate of Afghanistan

Ministry of Mines and Petroleum

TERMS OF REFERENCE (ToR)

FOR

PROCUREMENT AND SITE INSTALLATION

OF ACID GAS REMOVAL & GAS DEHYDRATION UNITS

FOR THE MID-STREAM NATURAL GAS SECTOR

Lump sum Contract

Final

Date: July 2023

Islamic Emirate of Afghanistan
Ministry of Mines & Petroleum
General Directorate of Hydrocarbons Management
2013
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1 Introduction

1.1 Background

Afghanistan's Ministry of Mines and Petroleum (MoMP) is in the process of tendering to procure two gas processing units, site installation, commissioning and start-up of the packages based on a turnkey contract.

The two gas processing units for acid gas removal and gas dehydration will be installed near the Yatimtaq natural gas field in the Sheberghan area, north-east Afghanistan - see Fig 1.

Non-associated gases from the Yatimtaq and nearby Khoja Gogordak fields currently supply treated gas by pipeline to the Northern Fertilizer and Power Plant in Balkh Province near Mazar-i-Sharif and will in future also supply the Bayat power plant located in Sheberghan, capital of Jawzjan Province area. New projects are planned in the Sheberghan and Mazar-i-Sharif areas will increase gas demands to beyond current gas processing capacities.

Figure 1 - Afghanistan. Area of operations in red

To cater for the increased gas demands, the Ministry of Mines and Petroleum (MoMP) plan to renew some existing gas processing units and supplement with new additional capacity units in the Khoja Gogordak and Yatimtaq area. Additional capacities of acid gas removal and gas dehydration units will initially be required and to be followed by in future inlet compression. An outline concept development is shown in Fig 2.

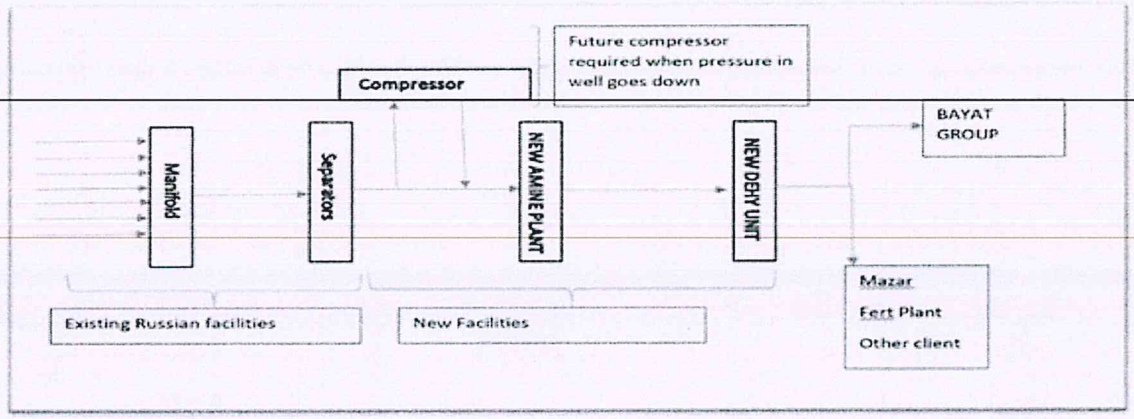

Figure 2 - Concept Development for the Yatimtaq Gas Plant

Ministry of Mines and Petroleum (MoMP) - the "Client" has appointed the Afghan Gas Enterprise (AGE) on their behalf to manage the midstream operations and provide a continuous supply of natural gas from the Sheberghan area.

1.2 Document Use

The similarities of the acid gas removal and gas dehydration processes makes it possible to develop this single ToR document to reflect requirements for both processes. Thus, in applying this document:

- The specifications or requirements specific for acid gas removal unit are given in Sections 4 and for gas dehydration unit are given in Sections 5.
- All remaining Sections refers to the specifications or requirements for both the acid gas removal and the gas dehydration units.
- In these common Sections (i.e., excluding Sections 4 and 5), where there is specific data or specification different for acid gas removal or gas dehydration, these will be stated explicitly.

2 Statement of Work

2.1 Objectives

The Afghan Gas Enterprise, acting on behalf of the MoMP, has been delegated to procure the additional acid gas removal and gas dehydration processing units, support installation of the units on site, integrate with existing facilities and then operate and maintain the gas processing plant to reliably supply on-spec product gas to customers.

The AGE Project will award a single turnkey contract for supply of both Acid Gas Removal and Gas Dehydration Units to extract synergies in supply of the process units, to reduce project coordination and management and simplify site activities.

This document provides the scope and technical specifications for an international specialist supplier / fabricator to:

- Supply of an acid gas removal unit using the amine wash technology and commonly referred to as Amine Unit
- Supply of a gas dehydration unit based on tri-ethylene glycol (TEG) absorption technology and commonly referred to as TEG unit
- Supply utilities/ancillaries as in scope of supply.
- Package amine, TEG processing units and ancillaries/utilities into skids / modules and transport to site
- Site installation/hook up of the skids/module and tie into existing plant
- Commissioning and startup of the process and utilities units until specified time after steady production of sales gas is achieved.
- Development, planning and implementation of a formal syllabus and on-the-job training program designed to train and qualify plant supervisors, operators and maintenance personnel in best practice for all aspects related to the operation and maintenance of the Acid Gas Removal and Gas Dehydration Units provided for here.

Throughout this document, the engineers / experts of the international supplier of the amine and TEG units will be referred to as the "Vendor".

2.2 Location

Both the amine and TEG units will be located at the following site in Afghanistan:

N: 36 40 458
E: 06 55 78 18
Allocated Area: as per the design
Elevation: as per the design

The Vendor shall reconfirm the location with AGE.

2.3 Supply Strategy

The Vendor shall supply the two main process units as a minimum number of skids / modules and individual dressed equipment (e.g. contactors, regenerators) - collectively called the respective Amine and TEG Process Packages.

The bulk of the Vendor's work relating to the design, engineering and fabrication of the Amine and TEG packages will be performed at the Vendor's location / workshop.

The Vendor shall study the optimum i.e. "minimum cost, minimum risk" location for fabrication site, module sizes, modules transportation and installation at Sheberghan site.

With AGE, Vendor shall be responsible for on-site hook up, tie-in to existing facilities, commissioning and startup of the Amine and TEG Units until specified time after stable operation is achieved.

Vendor shall minimize the scope of site installation, pre-commissioning, commissioning and start-up in the Sheberghan areas.

Some travel may be necessary between Afghan Gas Enterprise, the Northern Hydrocarbon Unit offices in Sheberghan and Ministry offices in Kabul.

2.4 Liaison with MoMP / AGE

The Ministry of Mines and Petroleum "the Client" will provide reasonable assistance to the Vendor to secure necessary licenses, visas, work permits and other documentations necessary for its operation in connection with the supply of the gas processing units.

The Vendor shall maintain close liaison with the Mr. Muhammad Tariq appointed as primary contact point of the Client for the sole purpose of the supply of the gas processing units in this ToR.

3 Design and Engineering Basis

3.1 Units

Quantities shall be presented in Customary units and conversion to SI units in brackets.

3.2 Codes and Standards

The Vendor shall explicitly refer in his documentation all applicable standards used. These shall include but not limited to the following Codes & Standards:

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a. Gas Processors Supplier Association (GPSA) Engineering Data Book, Fourteenth Edition 2017 for process guidance.
b. Equipment and systems shall be designed in accordance with the latest editions of international codes and standards listed:
   - API RP 520 Sizing Selection and Installation of Pressure Relieving Devices in Refineries (Parts 1 & 2)
   - API Std 521 Pressure Relieving and Depressuring Systems
   - API RP 14E Piping Systems
   - API RP 532 Measurement of the Thermal Efficiency of Fired Process Heaters
   - API Std 560 Fired Heaters for General Refinery Service
   - API Std 610 Centrifugal Pumps for General Refinery Service
   - API Std 661 Air-Cooled Heat Exchangers for General Refinery Service
   - API Std 674 Positive Displacement Pumps - Reciprocating
   - API Std 675 Positive Displacement Pumps – Controlled Volume
   - API Std 676 Positive Displacement Pumps – Rotary
   - API Std 685 Sealless Centrifugal Pumps for Petroleum, Heavy Duty Chemical and Gas Industry Services
   - API RP 945 Avoiding Environmental Cracking in Amine Units
   - TEMA Appropriate Standards for Tubular Exchangers
   - ASME II Materials
   - ASME VIII Pressure Vessels, Division 1
   - ASME IX Welding and Brazing Qualifications
   - ASME B16.5 Pipe Flanges & Flanged Fittings
   - ASME B31.3 Process Piping
   - NACE MR0175 Sulfide Stress Cracking Resistant Metallic Materials for Oil Field Equipment
   - NACE MR0103 Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments.
   - IEC 60079 Electrical Apparatus for Explosive Atmosphere
   - IEC 60529 Classification of Degrees of Protection Provided by Enclosures (IP Code)
   - NFPA 70 National Electrical Codes
   - NFPA-496 Standard for Purged and Pressurised Enclosures for Electrical Equipment
   - NEMA 250 Enclosures for Electrical Equipment (1000 Volts maximum)
   - EN 10204 Inspection Documents for the Delivery of Metallic Products
c. For Environment, Health and Safety, the International Finance Corporation (IFC) EHS Guidelines for Onshore Oil & Gas Development shall be used.

3.3 Site Conditions

The pertinent environmental conditions at Sheberghan, near to site location are:

Atmospheric Temperature range	-13° to 118° F (-25° to 48° C)
Annual Average Temperature	71.6° F (22° C)
Precipitation / Rainfall range	0 - 1.7 in (0 - 43 mm) / year
Average Annual Rainfall	8.4 in (213 mm)
Wind	45 kmph
Relative Humidity	Maximum 78 % / Minimum 31%

Design Air Temperature for air coolers: 104°F (40 °C) and a minimum approach of 18°F (10 °C)

4 Amine Unit

4.1 Scope of Supply

a. The Amine Unit shall consist of an Amine Contactor and the Amine Regeneration system with all ancillary equipment to remove H_2S and CO_2 (Acid Gas) from the sour feed gas stream.

b. Vendor shall supply the complete Amine System with all components skid mounted (with exception of large items such as amine contactor, amine regenerator etc), tested, pre-commissioned and ready for site installation and hook-up on foundations / concrete pads.

c. The amine unit shall include the following main equipment (- Figure 3 as typical):
   - Inlet Feed gas filter/coalescer vessel.
   - Amine Contactor (absorber).
   - Flash Drum/still with HC decanting facilities.
   - Lean Amine / Rich Amine heat exchanger.
   - Amine Regenerator Column.
   - Amine Reboiler with heating media e.g. fuel gas fired heater (with associated combustion air fans, burners, igniters, burner control system, burner snuffing package etc) or electrical heating with thyristor controls
   - Amine Regeneration Overhead Condenser.
   - Reflux Drum.
   - Reflux Pumps.
   - Lean Amine Booster Pumps.
   - Lean Amine Circulation Pumps.
   - Amine Filters (particulate and carbon).
   - Lean Amine Cooler.
   - Lean Amine surge tank.
   - Amine Solution storage and pumps.

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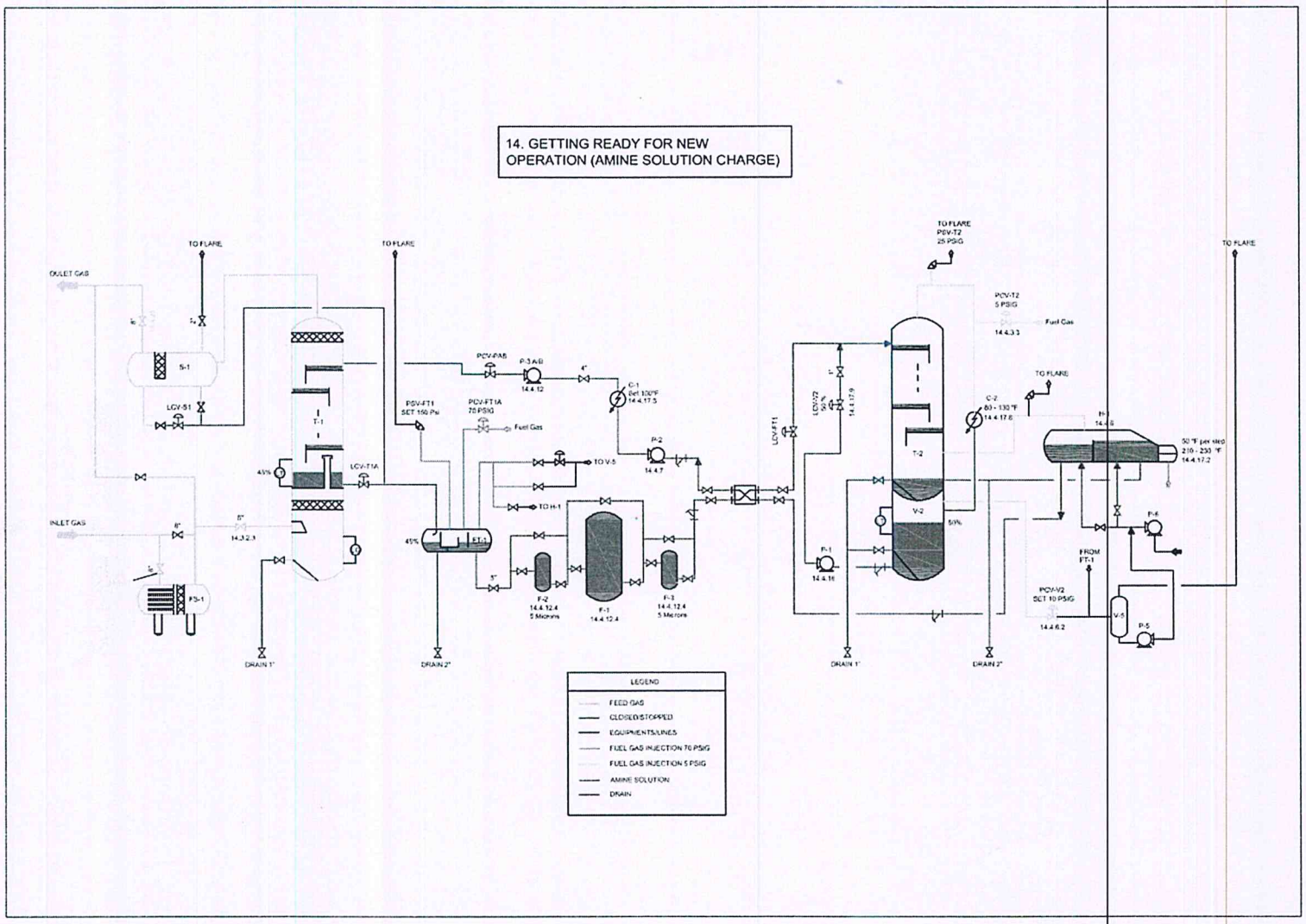

Figure 3 - Generic Amine Process Schematic

4.2 Amine Design Basis

4.2.1 Sour Feed Gas Compositions and Conditions

a. The compositions and conditions of the sour feed gas to the Amine Unit is given below.

Nitrogen	0.96 mol %
Methane	88.76 mol %
CO_2	8.9 mol %
H_2S	0.87 mol %
Ethane	0.44 mol %
Propane	0.05 mol %
i-Butane	0.01 mol %
n-Butane+	0.01 mol %
Inlet Pressure	800 psig (55.2 barg)
Feed gas flow	70.63 mmscfd (2 000 000 m3/d)
Inlet Water Content	Saturated at pressures and temperatures
Inlet Temperature	a heat exchanger is required before the absorber gas inlet to provision the temperature.

b. As field pressures decline and before provision of new inlet compression, the amine unit shall perform the acid gas removal duty with the feed gas inlet pressure at 500 psig (34.4 barg). Vendor shall state the impact on plant design and changes to be made when operating at the lower inlet pressure.

4.2.2 Treated Gas Specification

a. For both pressure design cases, the treated gas specifications are:

Outlet Gas H_2S Content	Less than 4 ppm (vol)
Outlet Gas CO_2 Content	Less than 0.2-0.4 %

b. The maximum allowable pressure drop across the amine contactor is 5 psi (0.35 bar).
c. Amine liquid carry over into the treated gas shall not exceed 0.05 USgal/mmscf (7 litre/mmscm).
d. Vendor shall specify the percentage of consequential removal of components such mercaptans, COS etc

4.3 Amine Unit Process Guarantees

For all design cases, the Vendor shall specify the expected and guaranteed values of process performance and parameters:

- H_2S, CO_2 content in the treated gas.
- Pressure drop across the Amine Contactor
- Lean amine concentration and circulation rate to achieve treated gas specification.
- Rich amine loading.
- Lean amine purity to achieve treated gas specification.
- Amine reboiler duties.
- Amine solution losses from contactor, flash drum, regenerator overheads and overall losses to include mechanical losses.

4.4 Amine Specific Requirements

a. Client has determined the MDEA based amine chemical wash system will perform process duty and specifications, yield an economic amine unit and will be compatible with operation of an existing MDEA unit located in the field.

b. The Vendor shall specify the amine solvent concentration; the lean and rich loadings; the circulation rates and reboiler temperatures for the two pressure design cases. For guidance only, the vendor will limit the MDEA amine design parameters to:

- Solvent Concentration, wt% 25-50
- Rich Loading, mol AG/mol amine 0.3-0.5
- Circulation, gal/mol AG 65-100
- Reboiler Temperature 250 °F (121°C)

c. Specific attention shall be given to the design measures to mitigate and manage hydrocarbons, impurities, degradation within the amine system. Such measures include:

- Inlet feed gas filter / coalescer vessel.
- Rich amine to the contactor is 9°F (5°C) above the feed gas.
- Hydrocarbon separation and skimming within the amine circulation loop e.g. in contactor base, flash drum etc.
- Filtration to be located on lean amine stream comprising of:
  - 2 x 100% solids filters (cartridge type), each with capacity to remove particulates from 100% of amine circulation.
  - 1 x 100% charcoal filter (cartridge type) with capacity to remove degradation products from a 10% slip stream of amine circulation.

  The cartridges for both filters should be provided with isolations to allow cartridges to be changed whilst amine unit is operating on-line.

- Skin temperatures in the amine reboiler tube do not exceed 150°C (300°F).

d. Special attention should be given to contacting efficiency of sour gas/amine and amine regeneration to achieve treated gas specifications. These include:

- Amine Contactor design with structured packing (or trays) and appropriate liquid / gas flow distributors, coalescing pads etc to ensure efficient gas/liquid contacting and minimising amine losses.
- Amine regenerator design with appropriate internals, reboiler and reflux systems to consistently achieve lean amine solvent loading, minimise amine losses and minimise amine degradation.
- Efficient heat recovery in the lean / rich amine exchangers with backup capacity in reboiler for mal-performance of the exchangers.

e. All equipment should be designed to incorporate a design capacity margin of 10% except:

- Reflux pumps, regenerator condensers and reboilers shall have a minimum 20% design capacity margin over maximum operating duty.
- Process plant pump differentials shall allow for 10% design margin on static head and 20% design margin on dynamic head for control purposes.
- Pump NPSH available should exceed NPSH required by at least 1m.

f. Vendor will include provisions for amine system make-up and chemical injection systems for chemicals (corrosion inhibitor, pH control, antifoam) to be used in normal operation and upset conditions.

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g. Vendor shall advise the utilities required (power, plant/instrument air, MDEA make up, fuel gas etc) for the amine unit.
h. Vendor will provide equipment sparing and other measures to meet a reliability target of 98-99% minimum.
i. Vendor shall advise the turndown available from the Amine Contactor and the Regeneration System.
j. Vendor will provide vents and drains systems to respective terminations at the amine package skids.

5 TEG Unit

5.1 Scope of Supply

a. The TEG unit shall consist of a Glycol Contactor (or Absorber) and the Glycol (or TEG) Regeneration system with all equipment to remove H_2O vapour and achieve dry gas specifications.
b. Vendor shall supply the complete TEG Dehydration system with all components skid mounted (with exception of large items such as glycol contactor, TEG regenerator etc), tested, pre-commissioned and ready for placing on foundations/concrete pads at site.
c. It shall include the following main equipment (- Figure 4 as typical):
    - Inlet Feed gas filter/coalescer vessel (not shown).
    - Glycol Contactor (absorber).
    - Rich TEG/ Regenerator Overhead Condenser.
    - Lean TEG / Rich TEG heat exchangers (two sets).
    - Flash Drum (with HC decanting facilities).
    - TEG Filters (particulate and carbon).
    - TEG Regenerator Column
    - TEG Regenerator Overhead Cooler (not shown)
    - TEG Regenerator Overhead k/o Vessel (not shown)
    - TEG Reboiler with heating media e.g. fuel gas fired or electrical heating with thyristor controls
    - Gas stripping of Lean TEG in Stahl column or equivalent
    - Lean TEG surge tank.
    - Lean TEG Circulation Pumps.
    - Lean TEG Cooler (or gas exchanger).

As per the weather conditions, a heat exchanger shall install before the absorber gas inlet to provision the temperature.

In TEG unit, for stabilizations of humidity in outlet gas and amount of liquid in inlet gas, 2 dewpoint equipment shall install before and after absorber.

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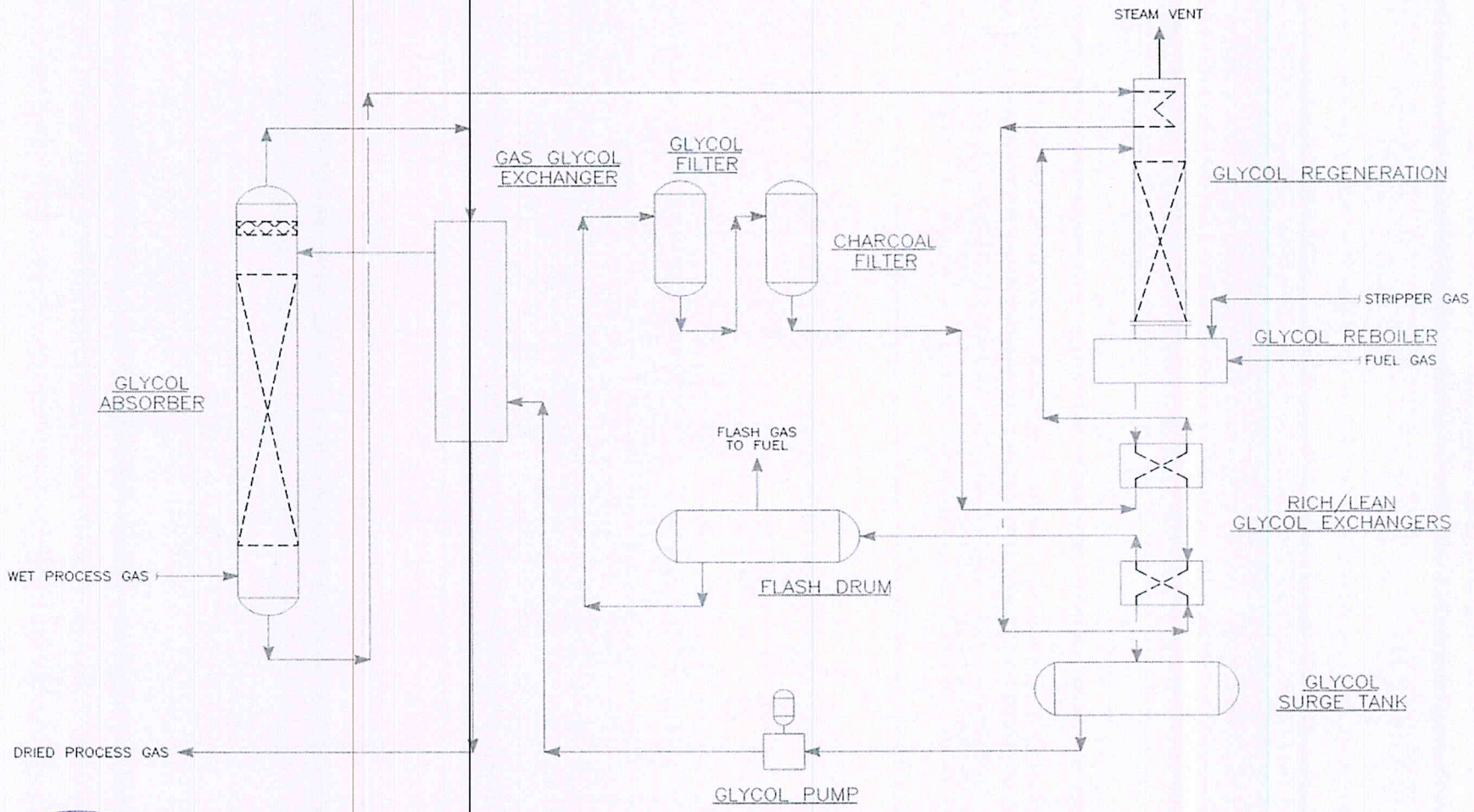

Figure 4 – Generic TEG Dehydration Process Schematic

5.2 TEG Unit Design Basis

5.2.1 Treated Gas Compositions and Conditions

a. Vendor shall confirm the compositions and conditions of the treated gas to the TEG unit based on the performance of the Amine Unit supplied by the Vendor for both pressure design cases - see Section 4. As a guide only, the expected composition and conditions of the feed gas to the TEG is given below, for information:

Nitrogen	0.32 mol %
Methane	98.14 mol %
CO2	0.72 mol %
H2S	<0.001 mol %
Ethane	0.69 mol %
Propane	0.09 mol %
i-Butane	0.02 mol %
n-Butane+	0.02 mol %
Inlet Temperature	120°F (48.9°C)
Inlet Pressure	795 psig (54.8 barg)
Feed gas flow	70.63 mmscfd (2 000 000 m3/d)
Inlet Water Content	Saturated at pressures and temperatures

[1] Amine Unit Vendor to provide the impurity levels based on co-absorption expected in the MDEA process

b. As field pressures decline and before provision of new inlet compression, the TEG unit shall perform the gas dehydration duty with the feed gas inlet pressure at 490 psig (33.8 barg). Vendor shall state the impact on plant design and changes to be made when operating at the lower inlet pressure.

5.2.2 Dry Gas Specification

a. For all the design cases, the dry treated gas specifications are:

Outlet Gas Water Content	Less than 4 lb/mmscf (0.06 g/sm3)

b. The maximum allowable pressure drop across the TEG contactor is 5 psi (0.35 bar).
c. Glycol liquid carry over into the treated gas shall not exceed 0.05 US gas/mmcf (7 ml/1000 sm3).

5.3 TEG Unit Process Guarantees

For all design cases, the Vendor shall specify the expected and guaranteed values for process performance:

- Water content of the dehydrated gas.
- Pressure drop across the TEG contactor.
- Lean glycol circulation rate required for water removal duty.
- Lean glycol purity to achieve the desired water content specification.
- Glycol reboiler duties.
- Stripping gas rates.

- Glycol solution losses from contactor, flash drum, regenerator overheads and overall losses to include mechanical losses.

5.4 TEG Specific Requirements

a. Client has determined the tri-ethylene glycol (TEG) system will perform process duty and specifications and compatible with operation of other gas dehydration units located in the field.

b. The Vendor shall use guidance in GPSA Data Book and present the calculation basis to specify the TEG dehydration process parameters - Lean TEG concentrations; specific glycol rates based on equivalent theoretical stages in the TEG contactor; TEG circulation rates; reboiler temperatures and stripping gas rates for the two pressure design cases.

c. Vendor shall specify the levels of BTEX co-absorbed into rich glycol and released in flash drum and still overheads.

d. Vendor's TEG process unit shall incorporate features to prevent atmospheric discharge of BTEX e.g. condensing and separating BTEX from flash gas and stills overheads prior to disposal of vapor stream to flare.

e. Specific attention will need to be given to the design measures to mitigate and manage hydrocarbons, impurities, degradation within the TEG system. Such measures include:
   - Inlet feed gas filter / coalescer vessel.
   - Lean TEG to contactor should be 9°F (5°C) above the feed gas.
   - Hydrocarbon separation and skimming within TEG circulation loop, e.g. contactor base, flash drum etc.
   - Filtration to be located on the rich TEG stream comprising of:
     - 2 x 100% solids filters (cartridge type), each with capacity to remove particulates from 100% of TEG circulation.
     - 1 x 100% charcoal filter (cartridge type) with capacity to remove degradation products from a 10% slip stream of TEG circulation.

     The cartridges for both filters should be provided with isolations to allow cartridges to be changed whilst TEG unit is operating on-line.

   - Skin temperatures in the TEG reboiler tube do not exceed 210°C (410°F).

f. Special attention should be given to contacting efficiency of wet gas/TEG and TEG regeneration to achieve dry gas specifications. These include:
   - TEG Contactor design with structured packing (or trays) and appropriate liquid / gas flow distributors, coalescing pads etc to ensure efficient gas/liquid contacting and minimising TEG losses.
   - Glycol regenerator design with appropriate internals, reboiler and internal reflux systems to consistently achieve lean TEG solvent concentrations, minimise TEG losses and minimise TEG degradation.
   - Efficient heat recovery in the lean / rich TEG exchangers with backup capacity in reboiler for mal-performance of the exchangers.

g. All equipment should be designed to incorporate a design capacity margin of 10% except:
   - Regenerator condensers and reboilers shall have a minimum 20% design capacity margin over maximum operating duty.

- Process plant pump differentials shall allow for 10% design margin on static head and 20% design margin on dynamic head for control purposes.
- Pump NPSH available should exceed NPSH required by at least 1m. Special attention is needed for pressure drop in the Lean TEG line from regenerator to circulation pumps and circulation pump NPSH requirement.

h. Vendor will include provisions for TEG system make-up and chemical injection systems for chemicals (corrosion inhibitor, pH control, antifoam) to be used in normal operation and upset conditions.
i. Vendor shall advise the utilities required (power, plant/instrument air, glycol make up, fuel gas etc) for the TEG unit.
j. Vendor will provide equipment sparing and other measures to meet a reliability target of 98-99% minimum.
k. Vendor shall advise the turndown available from the TEG Contactor and the Regeneration System.
l. Vendor will provide vents and drains systems providing respective terminations at the TEG package skids.

6 Common Units

6.1 Utilities

a. Existing site is supplied with utilities - power, instrument air, fuel gas and makeup water. At onset, Vendor shall ascertain the surplus utilities available to supply the additional amine and TEG units, the reliability and conditions of the utility units.
b. For bid purpose, Vendor shall include in the scope of supply the following utilities for the amine unit, TEG unit and any additional capacities identified:
   - Reliable supply of instrument air skids - 2x100%, with air intakes, air compressors, instrument air conditioning (cooler, driers), air and instrument air receivers.
   - Reliable power supply with engine generators, transformers and power distribution to consumers. Power generators will be 3x50% site gas generators and one diesel generator (with day tank) for start-up and emergency use. The voltage levels, phases and frequencies will be consistent with that used currently at site or within Afghanistan.
   - Fuel gas skid which will use treated and dehydrated gas downstream of the TEG unit, conditioned and pressure let-down. For start-up only, inlet feed gas to the amine unit can be used as fuel for short period until normal fuel gas stream is reinstated.
   - Demineralised water for MDEA solution and amine unit makeup. Facilities to include day tanks, raw water treatments filters, pumps, RO units to treat raw water (quality to be supplied prior to award) and produce demineralised water quality as follows:

Total dissolve solids (TDS)	- 100ppmw
Iron (Fe)	- 10ppmw
pH	- 7.0 - 7.7

6.2 Ancillaries

The Amine and TEG process packages shall include the following:

- Chemical Injection Package including tanks, pumps and instrumentation.
- Amine and TEG top-up facilities (e.g. day tank, pumps, piping and instruments).
- All instrumentation and controls within the amine and TEG package.
- Drip pans and common (closed and open) drains connections, amine drain sump.
- All stairways, platforms, structural supports, walkways, handrails and ladders for safe installation, operation and maintenance.
- All interconnecting piping, valves (manual, control valves, pressure relief and actuated), sampling points and fittings for operation and maintenance.
- Isolation method for the package and individual equipment, including double block & bleed, spectacle blinds or removable spools etc as required.
- Ducting for combustion air intake and exhaust stack within boundary of module if fired reboiler is used.
- All electrical (including lighting) and instrument cabling to junction boxes mounted at edge of the skids.
- Surface preparation, protective coatings, painting and name plates.
- Insulation and lagging for acoustic, thermal incl. trace heating and personnel protection.
- Passive and Active Fire protection, Safety equipment and Emergency lighting/facilities.

6.3 Acid Gas / VOC Disposal

a. There is approximately 7 te/d of sulphur in acid gases (H_2S and CO_2) removed from the amine unit if design H_2S levels and unit capacities are reached. This is insufficient to make sulphur recovery a viable proposition and, besides, process technologies to recover sulphur from approx. 94% CO_2 /6% H_2S mixture are complex, unreliable, high capex / opex and may not produce saleable product i.e. become a solid waste.
b. Vendor shall therefore consider disposal of acid gases from the amine unit together with BTEX from the TEG unit to the existing elevated flare with sufficient support fuel to enhance combustion.
c. Vendor shall carry out dispersion studies to demonstrate that ground level concentrations at key local receptors with population do not exceed environmental air emissions and ambient air quality guidelines [1].
d. Vendor shall allow tie-ins on the acid gas line for installation of a sulphur recovery unit and/or an H_2S / BTEX incinerator should a future detailed environmental study mandate it necessary to install them.

7 Technical Requirements

Vendor shall propose amine and TEG unit process systems design for reliable and consistent performance of specified duties to achieve treated gas specifications based on vendor experiences, best industry standards and best practice for amine / TEG units.

7.1 HSE

a. Vendor shall describe the handling of fresh chemicals (MDEA/TEG) based on their physical / chemical properties and the disposal of spent chemicals especially amines.

[1] International Finance Corporation - General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality, April 30, 2007

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Vendor to specify how the chemicals will be drained from system, where it will be drained to and how spent chemicals would be disposed.

b. Vendor shall describe properties of H_2S and its harmful effects such as short and long-term exposures to H_2S. Precautions that should be taken when in vicinity of H_2S or handling equipment / pipe work where presence of H_2S is expected shall be elaborated in the O&M Manuals.
c. Vendor shall provide an H_2S atmospheric monitor with warning system.

7.2 Process Safety

a. Vendor shall incorporate in their design features and safety measures consistent industry best practice for amine and gas dehydration units.
b. A Hazop shall be conducted by Vendor with Client representative participation at Vendor's location. The Hazop will pay attention to the significant HP/LP interfaces in the absorption and regeneration systems; presence of H_2S and in high concentration in selected streams and provide appropriate mitigation measures for identified risks. Special attention shall be given to controls for avoidance of entry of sour gas and/or water into the pipeline.
c. The Vendor shall ensure the process packages are protected from over-pressurisation in accordance with API RP 521. The Vendor shall determine the applicable relief cases and size the relief devices for all pressure / fire / other relief devices to API 520.
d. The amine and TEG units shall be designed for a minimum operating life duration of 25 years. Corrosion allowances shall be as specified in the equipment datasheets.

7.3 Mechanical

a. Mechanical design of all equipment including pressure vessels (incl. contactors, regenerator); heat exchangers (incl. reboilers etc); pumps; piping shall be to appropriate industry and international standards. A selection is given in Section 3.3 - Codes and Standards.
b. Materials of construction for all equipment covered by this scope of supply and in contact with the process fluid shall be selected and specified to meet the requirements of NACE MR0175 and appropriate corrosion allowances.
c. Special provisions will be made to equipment parts and piping in contact with corrosive rich amine solution, acid gas etc.
d. All regeneration system equipment shall have a minimum pressure of 100 psig (6.9 barg) with ability to withstand full vacuum. Pipe flanges shall be a minimum of ANSI Class 300 rating to minimise leakage.
e. All equipment, piping and other pressure containing parts shall be subject to a shop hydrostatic test.
f. External surface preparation, priming and painting shall be carried out after pressure tests have been satisfactorily completed.
g. Insulation shall be provided for energy conservation, personnel protection and freeze protection where appropriate.
h. Vendor shall provide sample points at appropriate locations to include monitoring amine and TEG conditions; for analyses of sour feed gas, treated gas, dry gas, acid gas (care!) and others as standard practice.

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7.4 Instrumentation, Control & Electrical

a. The amine and TEG units shall be designed for automatic operation and automatic safe shutdown without operator intervention.
b. Vendor shall select from the vast international standards for Instrumentation, Control and Electrical to use in the specifications for the process unit instrument and control system which include:
   - Local instrumentation panel with indication and control for manual start-up and manual shut down.
   - Local instrumentation panels with automatic controls, alarms, trips for operation and shut down.
   - Automatic process and emergency shutdowns without operator intervention.
   - A Supervisory Control and Data Acquisition (SCADA) system which repeat significant process parameters, alarms and other functions to enable plant technicians to monitor operations of the amine unit, TEG unit, utilities and attend to process alarms.
   - A process shutdown and emergency shutdown system in the Control Room.
   - On-skid Fire and Gas protective devices and extinguishant functions as appropriate for an onshore, well ventilated environment with panel in Control Room.
   - Electrical systems including earthing, lighting, cabling etc for hazardous areas classifications.
   - Provisions for installing temporary instruments and sampling for trouble shooting.
c. H_2S detection in congested parts of amine skids with risks of leaks and presence of high levels of H_2S which will alarm locally and repeat in Control Room.
d. On-line analysers with measurement levels and alarm indications in the Control Room should be provided on:
   - Treated gas line at outlet of amine contactor to continuously monitor H_2S with alarm functions.
   - Dry gas line at outlet of TEG contactor to continuously monitor water content with alarms and shutdown function.
e. Control room shall also have the facility for unit, plant and site shutdown during upsets, incidents or emergency situations; repeat of fire and gas alarms and of H2S alarms.
f. Repeat of SCADA information should also be set up for remote monitoring where required such as Client location and O&M Services Provider.
g. The full specification of the Control Room and SCADA system will be agreed with the Client.

7.5 Materials and Spares

The Vendor scope of supply shall include:

- First fill of amine and TEG (shipped in drums with nitrogen blanket), lubricants and consumables.
- Special tools required for Operations and Maintenance.
- Commissioning spares, Start-up spare parts, Insurance spares and two years operation spares.
- Preparing a list of recommended spare parts based in installation in a very remote location.

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7.6 Warranty

a. The Vendor shall guarantee:
   - All work to be free from defect in design, workmanship, materials, and equipment.
   - The operation of the units at design conditions as stated in the equipment data sheets for the duration of the warranty period.

b. The Vendor shall repair or reinstall, without cost to Client, any work, material, or equipment furnished by him that shall become defective or not operate in accordance with the design requirements except for wear and tear, during the progress of the work or during a period of twelve months after successful start-up.

8 Modularisation

8.1 Transportation

a. The Vendor scope shall include the transportation of all amine, TEG and associated skid or module units from Vendor fabrication location to in-country plant site near Sheberghan, Afghanistan. Whilst Client will provide support and assistance for Afghanistan in-country logistics, all hardware needed e.g. cranes, other lifting equipment etc shall be ascertained and provided by Vendor.

b. All equipment modules or skids packages shall be designed and prepared for shipment to installation site near Sheberghan, Afghanistan considering all transportation limits (weight, dimensions, cranes, tunnels etc) for selected transportation method.

c. Vendor shall advise the limits of outside dimensional data, shipping weights and layout on site for the proposed module / skid packages to allow the design of foundations at the site location.

8.2 Skid / Modules Units

a. The Vendor shall supply the Amine and TEG process units in minimum number of skid / modules and individual dressed larger equipment (e.g. contactors, regenerators) to minimize the scope of installation in the Sheberghan site.

b. The skid / modules layout shall be optimised based on equipment dimensions, equipment weights, bulks etc and critically consider the ease of operation and maintenance of the process units once installed at site.

c. All equipment, piping, instrumentation, electrical, controls etc required for system operations shall be mount on structural module(s). These should include walkways, ladders, platforms as needed for safe operation, inspection and maintenance.

d. Access for operations / maintenance activities e.g. replacement of cartridge filters; pump overhauls; instrument /valve overhauls etc., should be provided for without need for dismantling of pipework or cables.

e. Provisions for safe handling of equipment and components within the skid should be allowed for.

f. The layout on the skids shall have a minimum of 1.5 ft (0.5 m) clearance around main equipment and permit safe and efficient operational access to all valves, instrumentation.

g. Client shall be involved in Operability and Maintainability reviews of Vendors proposed skid / module layouts and site installations.

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8.3 Interfaces

a. The layout of the Amine and TEG skids/modules at the Sheberghan site shall be agreed with the Client.
b. Vendor shall supply complete plot plan, foundation and installation drawings for both the Amine and TEG skids/modules.
c. The Vendor scope shall **include** design, fabrication, supply and site hook-up of:
   - Interconnecting piping between the contactors and within the regeneration systems equipment of the amine and TEG units beyond the skid / module unit edge terminating points for site hook-up.
   - Interconnecting piping between the Amine Unit / the TEG Units to including main process lines, ancillary pipework (vents, drains etc) and utilities piping etc.
   - Interconnecting cabling, wiring and impulse lines between skid edge terminating points for equipment of the amine / TEG skids and between the amine and TEG packages.

8.4 Function Testing

To limit Vendor presence at site, the Vendor shall function test and document the Amine and TEG packages before delivery to include:

- Flushing on mechanical completion and hydrotesting
- Loop checking of all instruments and controls
- Individual equipment testing including function testing electrical motors, electric heaters, gas fired and reboiler controls etc
- Trial lift of each module skid and ensure no issues in on-site hook ups.

9 Scope of Site Services

The Scope of Site Services by the Vendor at sites in Sheberghan areas, Afghanistan is divided in two parts:

- Services that relate directly to the site installation and hook up of Amine and TEG unit skids/modules, commissioning and start-up of process units until steady operation and performance tests are completed.
- Services (- see 9.3 below) that relate to assisting with on-going Field Support and Training of local staff to international standards on Operation and Maintenance of such Hydrocarbon Gas Plants for a period of six months after steady operation of the amine and TEG unit's has been achieved.

9.1 Site Installation

a. Provide site support for hook-up of amine, TEG and utilities skid units and integration with existing facilities to a fully operable and safe gas plant.
a. Supported by AGE, the Vendor shall be responsible for:
   - erection of the skid and modules that make up the amine, TEG and utilities units on pre-prepared foundations at site and
   - all mechanical, piping, electrical, instrument and control hook up of the amine, TEG ad utilities modules / skids

b. Vendor scope shall also **include** the design, fabrication, supply, site tie-ins and hook-up of:
   - Process, utilities and ancillaries service piping
   - Cabling, wiring and impulse lines
   - Instrumentation, Control and Electrical (ICE) to central control facility

   from the defined skid edge termination points on the Amine, TEG and utilities skids/modules to the appropriate tie-in points within the existing plant.

c. Supported by AGE, the Vendor shall be responsible for on-site tie-ins from the Amine and TEG units to existing facilities.
d. Vendor and Client shall jointly conduct site reviews to include but not limited to:
   - Inspection to ensure installation of the Amine / TEG skid/module units and tie-ins within the units and to existing plant are mechanical completed.
   - All identified testing and pre-commissioning of equipment/pipework, Instrumentation, Control and Electrical (ICE) are completed
   - Testing and Inspecting Checklist is developed and completed to assure Mechanical Integrity of equipment and systems has been achieved.

9.2 Pre-Start up Safety Review

Vendor and Client shall jointly carry out a Pre-Startup Safety Review to establish Preparedness for Commissioning and Start-up of the gas plant. The scope of this review shall be developed by the Client and may cover, but not limited to below:

- Examine Hazard Analyses of the new/existing equipment and systems has been completed and actions closed out.
- Check Operating & Maintenance procedures for the new process units and the expanded existing processing plant have been produced.
- Employee training in Operation & Maintenance of the new process units and of the expanded existing plant is completed.
- Documents for Emergency procedures and control have been updated to include the additions of the new process units and applicable for the expanded plant.
- Safety and environmental information relating to chemicals uses, operation and maintenance of the new Amine and TEG unit are in place.
- A Safety, Commissioning and Startup plan to include Approvals needed before the plant start-up begins is in place.

9.3 Operation Services

Scope of site operation services cover the commissioning through to start-up of the Amine and TEG Units to process units until steady operation and performance tests are completed. Scope includes but not limited to:

a. Completion of the Safety, Pre-Commissioning and Start-up Checklist including Approvals.
b. Provide amine / TEG plant onsite commissioning and start-up activities to include instrumentation/electrical, control systems, mechanical, process adjustments, troubleshooting, etc until the gas plant fully meets production objectives.
c. Onsite training for operating personnel on Amine /TEG Unit Operations, Control, Shutdown, Troubleshooting and Preventive Maintenance.

d. Onsite training to ensure that all personnel and visitors to the amine / TEG units follow basic safety procedures to include lockout/tag out procedures, correct use of personal protective equipment, H_2S awareness/rescue/contamination avoidance and continuous safety process improvement activity.
e. Provide checklists and procedures that allow Afghan Gas Operators to safely and correctly operate and maintain the installed amine / TEG unit equipment to achieve gas production within specifications.
f. Develop and train on preventative actions to be taken to alleviate plant upset conditions and emergency actions.
g. Develop a template for logging and documenting production data, plant operations, process safety information and maintenance activities including corrosion monitoring and control.
h. Develop and implement a plan for routine/periodic preventative maintenance to include all on/off amine /TEG skid equipment as well as process adjustments (plan to include daily, weekly, monthly, etc. checks).

9.4 Performance Tests

a. Vendor shall prepare procedures for Performance Tests of the Amine and TEG units to verify compliance with the performance guarantees and agree with Client.
b. At appropriate time after amine and TEG unit start-up, the Client, with Vendor support, shall carry out the Performance Tests, analyse results and verify compliance with the performance guarantees. Vendor shall make any corrective engineering work until performance guarantees are achieved.

9.5 Field Support & Training

a. Development, planning and implementation of a formal syllabus and on-the-job training program designed to train and qualify plant supervisors, operators and maintenance personnel in best practice for all aspects related to the operation and maintenance of the dehydration and desulfurization facilities provided for here.
b. Coaching and develop progress report for issue daily as summary of production, operation, maintenance and plant issues.
c. Coaching and develop monthly progress reports on status of operations, maintenance, parts and training. Report to include any remediation of safety incidents.
d. Supply chain management for critical parts, sparing and associated inventory control.

10 Operations and Maintenance Manual

Vendor scope shall include developing comprehensive Operation and Maintenance Manuals in English for both the Amine Unit and the TEG unit. It also includes developing / translating specific manuals in the official Afghan local language - Pashto/Dari.

10.1 O&M Manual

The contents of the O&M manuals written in English for the Amine and the TEG units separately shall include for each but not limited to:

- Basis of Design Sections that includes Design Cases and Specifications; Process Description and Drawings; Main Equipment Details; Key Process Controls, Alarms and Shutdowns; H_2S and Design Safety Features

- Preparation for initial start-up to include water flushing; degreasing; demineralised water flush; preservation; initial amine fill
- Normal Start-up Procedure to include pressurisation with feed gas; amine/TEG solvent circulation; start-up of amine/TEG regenerator; introduction and establishing feed gas flow; achieving treated/dry gas specifications
- Normal Operation to include defining the operating variables for amine / TEG absorption and regeneration system; process control variable; HC control
- Amine / TEG Regeneration System Operation to include monitoring Solvent Health and Analyses; Solvent make-up, Filter change outs; Foam Control
- Normal and Emergency Shut-down Procedure for Amine/TEG Absorber and Regeneration Systems to include Utility Failures and Restart
- Performance Monitoring to include: a) monitoring process parameters daily e.g. lean amine flow / temperature, reboiler pressure / temperature, pressure drop across contactor / regenerator, filter pressure drops, solvent losses/make-up; b) Visual Inspection (daily) and Laboratory Analyses of rich and lean amine / TEG samples to check loading, pH, HC content, HSS, foam test etc.
- Troubleshooting Guide describing information/analyses needed and action/possible solutions to common amine /TEG system problems including foaming in absorber / regenerator; non-achievement of treated/dry gas specification; inadequate amine/TEG pickup; poor lean amine/TEG quality; circulating solution condition (discoloured, high particulates); HC entrainment; high amine/TEG losses
- Safety Procedures to include Sampling; Repair work e.g. Filter Changeout; Safe Handling of Volatile and Toxic Material; Fire Fighting and Protective Equipment; Emergency Fire Plan
- Maintenance Procedure to include preparation for maintenance; Isolation Procedure for Individual Equipment and Unit Isolation; Routine, Breakdown and Planned Preventive Maintenance; Inspection; Turnarounds

10.2 Manuals in Local Language

a. Develop and translate HSE manual in the official Afghan local language - Pashto/Dari with emphasis on safety and incorporation of safety in all aspects of operations and maintenance.
b. Translate the Operation and Maintenance Manuals for the Amine Unit and the TEG Unit into the official Afghan local language – Pashto/Dari.
c. Develop with Afghan Gas Operators the valve-by-valve Operations, Control, Shutdowns and Troubleshooting Manual for the Amine Unit and the TEG Unit in the official Afghan local language - Pashto/Dari.

11 Design and Engineering Dossiers

Vendor scope shall include provision of Design and Engineering Dossier for the Amine and the TEG Units - one each. Such dossier will contain pertinent design and engineering information; manufacturing data dossier (incl. packaging and interface information); operating and maintenance manuals - the index of content of both dossiers shall be agreed / approved by the Client.

11.1 Design Information

Typical content for the dossiers shall include:

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- Process design information (design cases, specifications, process description etc)
- Heat and Mass Balance Stream summaries to include:
    - For Amine Unit
        - Sour gas feed to and treated gas from the amine contactor
        - Lean Amine to and Rich Amine from the amine contactor
        - Flash gas and Acid gas from the regenerator
        - Reboiler temperature and duty
        - Solvent details for all design cases including solvent concentration, circulation rate and Lean//Rich amine loading
    - For TEG Unit
        - Wet treated gas feed to and dry gas from the TEG contactor
        - Lean TEG to and Rich TEG from the TEG contactor
        - Flash gas and Steam/Vent gas from the regenerator
        - Reboiler temperature and duty
        - Solvent details for all design cases including Lean %wt TEG, Rich TEG wt% and circulation rate
- Complete Heat and Material balance for design cases from amine/TEG process simulations
- Controlling parameters selected for amine/TEG unit designs

11.2 Engineering Information

- Engineering, operating and performance design data and sizing calculations for all equipment items
- Data sheets to include capacities, duties, dimensions, duties, internals etc. for all main equipment (vessels, reboilers, filters, pumps, exchangers etc)
- Utility requirements (power, air etc) required for the amine unit for all design cases; the total amine inventory and initial charge.
- Piping and components bill of material
- Structural drawings and design calculations
- Hazop dossier documenting all scenarios examined and mitigation measures
- Relief and Blowdown including relief scenarios and blowdown and all calculations for scenario loads, relief valve, relief / blowdown piping etc

11.3 Manufacturing Data Dossier

- All data/information relating to purchased Mechanical, Instrument, Control and Electrical items
- Interface schedules giving location, sizes, pressure ratings etc of all connections between the skid unit that make up the amine / TEG packages
- Interface schedules giving location, sizes, pressure ratings etc of all connections between the amine / TEG package and external units to the Client gas plant
- Estimated plot area required.
- Process, Mechanical and Structural Design of the amine / TEG package units incl. tagging, internal and external painting / coating
- Quality Assurance, Inspection and Testing
- Fabrication and assembly of the amine / TEG skids
- Earthing bosses for skids and individual equipment items
- Preservation, Packaging and marking for transportation
- Spreader bars, slings and shackles for installation of the module or module components as transported using single point lift

11.4 Drawings

The drawings shall generally include the following:

- Process flow diagrams (PFD) including flows, compositions, pressure and temperature of all significant streams
- Piping and instrument drawings (P&IDs)
- Drawings for all items of equipment (vessel, reboiler, filters, pumps, exchanger etc) including internal, instruments and control/shutdown/relief valves
- Piping plans, sections and details including supports
- Instrumentation & Control detail drawings and data sheets
- Electrical schematics and detail drawings
- Shutdowns, Cause & Effects charts
- Assembly piping drawings consisting of, as a minimum, plans, elevations and sections as required for dimensional elevations of piping and components
- Module / Skid layout, showing access platforms, walkways and clear access areas
- General arrangement drawings for all amine / TEG package module / skids
- Skid framing plans, sections and details

11.5 Operation and Maintenance Manuals

- Operation & Maintenance Manuals (see Section 10)

12 Language

English Language shall be used in all technical communication for the design, engineering, fabrication and installation except for specific requests made in this ToR where translation of selected documents to the official Afghan local language – Pashto or Dari is required.

13 Duration of the Contract

The duration of the contract is Eight (8) months from the date of contract effectiveness until the commissioning of acid gas removal and gas dehydration units, along commissioning for Field Support and Training of local staff to international standards on plant Operations and Maintenance of acid gas removal and gas dehydration units.

14 Vendors Experts

The vendors' responsibility will be to design, modify, deliver, install and commission both units and, in consequence, it will be the vendors' responsibility to ensure that its staff can complete the scope of work with the involvement of key experts and supporting staff.