



**SPECIFICATION
FOR
GAS DEHYDRATION & GLYCOL REGENERATION UNIT**

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1. SCOPE OF SUPPLY

- 1.1. This Specification covers the minimum requirements for the design, materials, fabrication, testing, inspection and shipment preparation three (3) "Gas Dehydration and Glycol Regeneration Units", hereinafter referred to as "D&R Units", using tri-ethylene glycol (TEG) to remove water vapour from the natural gas stream at Company's natural gas producing fields.
- 1.2. For the purpose of this Specification, the term "Company" shall refer to "Turkish Petroleum Corporation" and the term "Supplier" shall refer to the party with whom Company enters into an agreement for the purchase, delivery of goods and performance of associated services; or any company, firm, organization or individual bidding for supply and associated services, in accordance with this Specification and other contractual documents listed elsewhere.
- 1.3. Supplier proposals shall comply with requirements set forth in this Specification. Contradictions in this Specification, if any, shall be clarified in writing.
- 1.4. It is not the Company's intent to specify all technical requirements nor to set forth those requirements adequately covered by applicable codes and standards. The Supplier shall furnish high quality equipment meeting the requirements of this Specification and industry standards.
- 1.5. If the Supplier is in the opinion that he will not comply with any requirement of this specification, he shall submit a detailed list of exceptions with his bid; otherwise, bids will be assumed to be in full compliance with this Specification during bid evaluation and for the associated purchase order.
- 1.6. Supplier is responsible for complete engineering, sizing, material & equipment selection, instrumentation, controls and other accessories as required by process conditions.
- 1.7. The Supplier shall provide additional equipment and instrumentation necessary to ensure proper operability and to provide the equipment in accordance with the intended purpose as specified in this Specification.
- 1.8. If Supplier deems any modification will improve the design or be more beneficial from economic point of view, he shall be free to propose an alternative.
- 1.9. Since the D&R Units will be used in remote, unmanned locations, the Supplier shall ensure the units to operate safely and continuously outdoors under specified site conditions.
- 1.10. Supplier shall ensure that the shipping dimensions and load size required are practical and acceptable to the authorities of all routes through which the D&R Units must pass on its route to point of delivery.
- 1.11. Due to high pressure working conditions, metallurgy required for high strength applications and API standards, North American and/or West European manufacturers are preferred. Chinese origin manufacturers and equipment will not be accepted within the scope of this tender.

2. CODES AND STANDARDS

- 2.1. The D&R Units shall be designed, fabricated and tested in accordance with the following codes and standards. These codes and standards provide minimum requirements and Supplier's design shall meet or exceed these requirements. The most recent edition of the codes and standards shall be applicable.
- 2.2. ASME Sections VIII Div. 1 Pressure Vessel Code
- 2.3. ASME B31.3 Process Piping
- 2.4. API SPEC 12GDU Gas Dehydration Units.
- 2.5. API SPEC 12J Specification for Oil and Gas Separator.
- 2.6. API STD 660 Shell and Tube Heat Exchangers for General Refinery Services
- 2.7. API Standard 674 Positive Displacement Pumps Reciprocating.
- 2.8. API RP 553 Refinery Valves and Accessories for Control and Safety Instrumented Systems
- 2.9. API STD 520 Sizing, Selection and Installation of Pressure-Relieving Devices Part I: Sizing and Selection; Part II: Installation
- 2.10. ISA 75.01 Flow Equations for Sizing Control Valves
- 2.11. 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 (for regenerator only)
- 2.12. WRC Bulletin 297 Local Stresses in Cylindrical Shells Due to External Loadings on Nozzles-Supplement to WRC Bulletin No 107 (for regenerator only)
- 2.13. National Electrical Code (NEC), Tubular Exchanger Manufacturer's Association, (TEMA), International Electrotechnical Commission (IEC), International Organization for Standardization (ISO), American Institute of Steel Construction (AISC) Codes and Standards as applicable.
- 2.14. Supplier shall submit ASME U certificate in his quotation.
- 2.15. Supplier shall submit the quality assurance certificates it holds in his quotation. (ISO 9001 etc.)

3. SITE CONDITIONS

Location	: Thrace Area, North-West Turkey
Altitude	: From 0 m to 50 m
Temperature Range	: -24 °C to 42 °C
Rainfall Annual-Ave	: 563 mm.
Design Seismic zone	: Zone 3 (Peak Ground Acceleration: 0,2g)
Relative Humidity	: 10 - 100 %
Design Wind Velocity	: 120 km/hr (1 hour)

4. GENERAL TECHNICAL REQUIREMENTS

4.1. General Process Description

- 4.1.1 The function and main purpose of the D&R Unit shall be to remove water from natural gas stream in such a way that the hydrate formation is eliminated.
- 4.1.2 Outlet gas water content shall not be greater than 7 lb/MMSCF.
- 4.1.3 The inlet gas (from separators) will pass through the glycol contactor. The maximum pressure drop in the gas stream through the entire dehydration system shall not exceed 30 psi (2.1 bar), and no substantial temperature change shall occur.
- 4.1.4 D&R Unit shall comprise one glycol contactor and one regeneration package all installed and mounted on a structural steel skid.
- 4.1.5 D&R Unit shall include all necessary piping and instrumentation as ready to run for start-up, safe and continuous operations.
- 4.1.6 D&R Unit will be used at a remote, unmanned location. Supplier shall provide the unit for continuous outdoor duty for site conditions as specified.
- 4.1.7 Piping and tubing shall be installed above the skid floor. All user connections shall be located at the skid edge.

4.2. Design Parameters for Glycol Dehydration Units

4.2.1 Type 1 (TPAO SAP No: 1290040000004)

Maximum Inlet Gas Flow Rate, MMSCF/D	: 2,5
Design Temperature, °F	: 120
Design Pressure, psi	: 720
Operating Pressure Range, psi	: 180 - 230
Operating Temperature Range, °F	: 80 - 100
Quantity	: 1 Required

4.2.2 Type 2 (TPAO SAP No: 1290040000003)

Maximum Inlet Gas Flow Rate, MMSCF/D	: 3,5
Design Temperature, °F	: 120
Design Pressure, psi	: 720
Operating Pressure Range, psi	: 180 - 230
Operating Temperature Range, °F	: 80 - 100
Quantity	: 1 Required

4.2.3 Type 3 (TPAO SAP No: 1290040000002)

Maximum Inlet Gas Flow Rate, MMSCF/D	: 5
Design Temperature, °F	: 120
Design Pressure, psi	: 720
Operating Pressure Range, psi	: 180 - 230
Operating Temperature Range, °F	: 80 - 100
Quantity	: 1 Required

4.3. Typical Gas Composition

D&R Units will be used in different gas fields. The minimum, maximum and average percentages of the gas components of these gas fields are given below.

Composition % mol	Min %	Max %	Average %
C ₁	90,90%	96,37%	92,81%
C ₂	0,67%	4,80%	3,17%
C ₃	0,15%	1,80%	1,07%
i-C ₄	0,06%	0,52%	0,26%
n-C ₄	0,09%	0,60%	0,29%
i-C ₅	0,00%	0,26%	0,11%
n-C ₅	0,00%	0,36%	0,10%
n-C ₆	0,00%	0,21%	0,10%
N ₂	0,30%	3,42%	1,64%
CO ₂ *	0,00%	2,53%	0,44%

* Partial pressure for CO₂ will be lower than 7 psig for all operating conditions, and considered non-corrosive. These criteria shall be used for material selection and design of the equipment and its components by the Supplier.

The feed gas will be saturated with water vapour at relevant P and T.

5. EQUIPMENT, INTERNALS, INSTRUMENTATION & SKID

5.1. GENERAL

- 5.1.1 Design life of the units shall be minimum 20 years.
- 5.1.2 Units shall be provided with necessary piping, fittings, tubing, cabling, trays and all other main and auxiliary equipment.
- 5.1.3 The unit shall be furnished with the necessary instrumentation and control equipment for unattended operation.
- 5.1.4 Thermal insulation shall be installed on vessels and piping as required to prevent excessive heat loss and ensure cost efficient operations.
- 5.1.5 Generally, a corrosion allowance of 1/16" shall be used for the D&R Unit.

- 5.1.6 All equipment shall be mounted on a rigid oil-field type steel skid. All equipment, piping, instruments and cables shall be located within the skid limits.
- 5.1.7 All terminating lines shall be extended to the edge of the skid and terminated with a full threaded flanged
- 5.1.8 The Supplier shall provide a complete protective coating in accordance with Supplier's coating procedures and practices. Coating shall be a 2-layer type as a minimum. All coating work shall be performed after completion of required tests. Generally, stainless steel surfaces shall not be abrasive blasted or painted.
- 5.1.9 ASME Data Tag
ASME nameplate shall be attached on the Glycol Contactor and Regeneration Package Unit and shall include as a minimum the following information:
- Name of Manufacturer
Maximum Design Pressure
Maximum Design Temperature
Maximum Flow Rate of Gas Stream
Manufacturer Serial Number
Date Built
- The weight (kg) of the Glycol Contactor and Regeneration Package Unit.
- 5.1.10 The D&R Unit glycol contactor and regeneration package shall include, but not limited to, the equipment described in this Specification.
- 5.1.11 The following information shall be completed where applicable and submitted to COMPANY for review and approval prior to the start of any fabrication:
- Engineering, operating and performance design data and sizing calculations for all items,
 - Vessel, reboiler, filter and exchanger drawings

5.2. GLYCOL CONTACTOR

The glycol contactor shall include integral inlet scrubber, two stainless steel wire mesh mist extractor, external gas/glycol heat exchanger, necessary piping, control valves. Bubble trays with bubble caps or structured packing shall be used in the glycol contactor design.

5.2.1 Liquid Level Controller

Since glycol contactor is integrated with integral inlet scrubber, there shall be two pneumatic liquid level controllers. One of them shall control level of water and condensate accumulated at

the bottom of integral inlet scrubber. The other one shall control level of glycol in the glycol contactor. Both of them shall have sight glasses.

5.2.2 Pneumatic Liquid Valve

Two pneumatic liquid valves shall be provided. As level of water and condensate reaches to a certain value, one of the valves shall be actuated and drain condensate and water from the contactor. The other shall be used to dispatch glycol from the unit when certain amount of glycol is accumulated in its own compartment.

5.2.3 Pressure Safety Valves

Pressure Safety Valves supplied with the glycol contactor shall be in accordance with the API Standard 520. Pressure Safety Valve shall be set at 600 psi.

5.2.4 Stainless Steel Wire Mesh Mist Extractor

Two mist extractors, which cover the cross-sectional area gas passing, in the glycol contactor and integral inlet scrubber shall be provided. Main purpose of mist extractor is to extract entrained liquids (glycol and condensate) from the gas stream and not allow them to escape from the contactor.

5.2.5 Instrument System

Pressure gauge with isolation valve and thermometer with separable socket shall be provided on the glycol contactor. All other necessary instrumentation and installation accessories shall be provided.

All pressure gauges on the unit should be glycerin-filled.

5.2.6 2" Blind Flanges

Each tray on the shell side of the glycol contactor shall be equipped with a 2-inch threaded blind flange (or blind plug) to facilitate maintenance, inspection, and cleaning activities.

5.3. REGENERATION PACKAGE

The regeneration package shall include horizontal glycol reboiler, removable U-type fire tube with flame arrested burner assembly, removable stack assembly with bolts and gasket, removable still column packed with ceramic saddle or stainless-steel pall ring. It also shall include filter, glycol/glycol heat exchanger, two phase separator, three-way temperature control valve, two gas powered glycol pump (second pump as stand-by), surge tank, all other equipment, parts, piping, tubing and valves.

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The glycol regeneration system must be self-sufficient with a burner designed for natural gas. Burner management system shall be Profire made or equivalent and equipped with solar panels to support operations at remote locations.

The solar panels and gel-type battery system shall be sized to supply continuous power to the system for a minimum of six (6) days under adverse weather conditions, including periods of cloudy weather with limited solar irradiation. The battery capacity calculation shall be based on a design margin of 2. The solar charge controller shall be of the MPPT type. The electrical panel shall be adequately sized and arranged to allow easy installation, operation, and maintenance of the batteries and solar charge controller. The Contractor shall submit all relevant design calculations and documentation for review and shall obtain approval prior to implementation.

Regardless of the results of the design calculations, the installed solar panel capacity shall not be less than 580 W, and the battery capacity shall not be less than two (2) units of 100 Ah each. These values shall be considered as the minimum allowable capacities.

The solar panel mounting frame shall be hot-dip galvanized. A minimum 10-meter-long power supply cable shall be provided to allow flexible positioning of the solar panels in a location that ensures unobstructed exposure to sunlight.

All skids and structural frames shall be provided with dedicated grounding lugs or grounding holes to allow proper connection to the grounding (earthing) system.

5.3.1 Glycol/Glycol Heat Exchangers

Exchangers supplied with the unit shall be in accordance with the applicable codes and standards of Tubular Exchanger Manufacturer's Association (TEMA) and API STD 660 – Shell and Tube Heat Exchangers for General Refinery Services.

5.3.2 Surge Tank

The surge tank for atmospheric service shall comply with the relevant standards and codes.

5.3.3 Pumps

Pumps used to circulate lean TEG shall be gas powered Kimray SC types, reciprocating units. One fully operational spare glycol pump shall be provided for each type of design.

5.3.3.1 Pumps must be capable of circulating a minimum of 2 US Gallons of lean glycol per pound of water removed.

5.3.3.2 Pumps design shall be in accordance with API STD 674, Positive Displacement Pump - Reciprocating. Pumps shall be provided with individual pulsation dampening devices.

5.3.3.3 Two spare repair kits for each pump shall be included in the regeneration package.

5.3.4 Filters

Filters shall be provided for filtration of solution impurities from the rich glycol solution.

5.3.4.1 Design of the filters shall be in accordance with applicable codes.

5.3.4.2 The glycol filter shall be a vertical cartridge type with skirt support, and swing bolt top head closure.

5.3.4.3 An internal relief valve shall be provided with the glycol filter to protect the filter elements against excessive differential pressure.

5.3.4.4 Top head shall be equipped with a safety bleed-off device to insure zero internal pressure before opening.

5.3.4.5 Filter shall be equipped with a stainless-steel differential pressure gauge. The gauge shall have a range of not greater than 0-4 bar (0-60 psi) differential pressure.

5.3.4.6 Cartridge elements shall be easily removable for replacement and shall be of the wound-cylindrical cone-type with element filter medium material to be suitable for filtration of the process fluid (≤ 5 micron).

5.3.4.7 The filter system shall include one carbon filter, in the rich glycol line, with block valves and a by-pass line.

5.3.4.8 Two spare filters for each filter shall be included in the regeneration package.

5.3.4.9 ASME nameplate shall be permanently attached to the filter and shall include as a minimum the following information.

- a. Name and address of manufacturer.
- b. Maximum design pressure.
- c. Maximum design temperature.
- d. Manufacturer's serial number.
- e. Date built.
- f. Specified tag number.
- g. Rated capacity.
- h. Test pressure.
- i. Recommended pressure differential for element cleaning.

5.3.5 Separator

Separator supplied with the regeneration package shall be in accordance with the API Spec 12J. Vessel shall be used to extract gas from TEG before glycol enters the horizontal glycol reboiler. Gas coming out of the separator will be used as fuel gas and instrument gas. Separator shall also include glycol level control and control valve to keep level of glycol at certain value in two phase separator.

5.3.6 Three-Way Temperature Control Valve

There shall be three – way temperature control valve provided to keep temperature at a predetermined level (101,5 °C, to be verified) on top of the still column.

5.3.7 Instrument System

The regeneration package shall include firing system, fuel gas manifold system, fuel gas regulators, strainer, burner, pilot assemblies, thermostats, safety systems, thermometer with thermo-well and all other necessary equipment.

5.3.8 Thermostat

Two thermostats shall be provided on the regeneration package. One of them on the regeneration package unit senses the temperature of glycol and regulates the fuel gas for heating glycol, the other one senses the temperature of top of still column and regulates the three- way control valve used to keep temperature on top of the still column at specified temperature.

5.4. CONTROL AND INSTRUMENTATION

5.4.1 All instruments of the same type shall be supplied from the same manufacturer.

5.4.2 Local indicating instruments, pressure gauges, and temperature indicators shall be supplied to adequately monitor the whole process.

5.4.3 Instrumentation design, supply and installation shall be in accordance with relevant codes and standards set forth in this Specification and best industry practices.

5.4.4 Supplier is responsible for providing all instrumentation for smooth and safe operation and guarantee the performance of the unit.

5.5. STEEL STRUCTURAL SKID

- 5.5.1 The skid shall be designed and fabricated and be easily loaded to and transferred by standard trucking equipment. Skid package dimensions shall comply with Export Packing codes.
- 5.5.2 Lifting lugs shall be provided on the skid for four-point lift.
- 5.5.3 Skid shall be designed and fabricated in accordance with AISC codes. For the design, the Supplier shall consider loads imposed by lifting, transportation and normal operation.

6. DOCUMENT REQUIREMENTS

6.1. Supplier's proposals shall, as a minimum, include the following:

- Data sheets, drawings, P&IDs, list of applied codes and standards, dimensional outline, general arrangement plans, total weights, any literature to supplement the documents and all such information which is necessary to fully understand the proposal from technical point of view.
- Deviation or exceptions to the Specification, if any.
- List of mandatory spare parts, where specified, along with their unit prices.
- List of Supplier's standard spare parts for two years of normal operation, along with their unit prices.

6.2. Supplier shall furnish one hard and two soft copies (burned into a CD-ROM or DVD-ROM) of Technical Data Manual for the equipment, any auxiliaries and instruments that the Supplier is providing. The Technical Data Manual shall include the following as a minimum:

- All data sheets, P&IDs, electrical/mechanical/instrumentation drawings, wiring diagrams, structural drawings and typical foundation drawings.
- Design simulation outputs & performance curves.
- Shop test report.
- Operation and Maintenance Manual. This manual shall provide sufficient written instructions and data to enable the Company to correctly operate and maintain the equipment ordered.
- Separate dedicated equipment catalogues for each unit.
- Top sheet of each volume of Technical Data Manual shall contain the contact information of the Supplier.

6.3. Supplier shall utilize industry standard drawing practices as a minimum in executing the work. All drawings shall utilize title blocks and revision blocks for drawing identification and control. All drawings shall be dated and signed by appropriate Supplier representatives. When revised,

Supplier shall identify revisions on drawings with clouds and revision triangles and the title and revision blocks shall be appropriately completed with descriptions, dates, and signatures.

7. PERFORMANCE AND WARRANTY

- 7.1. The Supplier shall have the final and total responsibility for the design and performance of all equipment supplied under this specification. Completed equipment and auxiliaries furnished by the Supplier shall be guaranteed by the Supplier to be suitable for the services described herein, to be in full compliance with all applicable codes and standards and to safely meet all performance and service requirements under all design conditions identified in this Specification.
- 7.2. The Supplier shall warrant that all equipment furnished under this specification shall be suitable for its intended purpose and given gas quantities, conditions and compositions.
- 7.3. The Supplier shall notify Company, in writing, with all details for the Factory Acceptance Tests at least 4 weeks prior to the planned dates. Test procedures shall be submitted at least 2 weeks before the tests are conducted. Company may participate in the tests at its own discretion and will respond formally to the notification. Supplier shall provide minimum services such as but not limited to office desk, electricity, internet access and printing facilities, free of charge, for Company's up to two representatives during tests. Acceptance or approval of any drawing, design and tests shall not relieve Supplier from its responsibilities to provide a fully functional unit designed and manufactured in accordance with the codes, standards and best industry practices.
- 7.4. The Supplier shall guarantee all materials and workmanship to be free of defects for a period of 18-months after startup or 24-months after shipment, whichever occurs first. Supplier shall, at his expense, replace or repair any materials found to be defective prior to or during this warranty period.
- 7.5. The Supplier shall, if deemed necessary by Company, provide the services of a trained and qualified technician or engineer to coordinate the correction of defects or operating abnormalities during the warranty period at no additional cost to Company.
- 7.6. The Supplier shall guarantee the availability of spare parts for the gas dehydration units at least for 10 years.