

GENERAL SPECIFICATION

PROCESS

GS EP ECP 101

Glycol package unit

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1. Scope

1.1 Purpose of the specification

This specification details Company's minimum requirements for the design, manufacture and performance of Tri Ethylene Glycol (TEG) gas dehydration package units.

This general specification does not remove the responsibility of the Vendor who will outline in his technical proposal any deviation to the clauses of this specification and will guarantee the unit performance in the long run.

1.2 Applicability

This document is concerned with glycol package units with conventional generation process to be installed either offshore or onshore. It does not cover other gas dehydration technologies. It does not cover either licensed TEG regeneration units. Specific requirements from licensors generally prevail.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
API 674	Positive Displacement Pumps - Reciprocating
GPSA	Engineering Data book GPSA vol II chapter 20 (11 th edition 1998)

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Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP ECP 103	Process sizing criteria
GS EP ELE 011	Electrical requirements for packaged units
GS EP INS 110	Instrumentation for package units
GS EP MEC 028	Rotating Machine Package Specification - Positive Displacement Motopump according to API Standard 674
GS EP PVV 415	Design and fabrication of air cooler
GS EP PVV 813	Skid mounted units for static equipment
GS EP SAF 216	Area classification
GS EP SAF 227	Safety rules for fired heaters
GS EP SAF 228	Liquid drainage
GS EP SAF 261	Emergency Shutdown and Emergency De-Pressurisation (ESD & EDP)
GS EP SAF 262	Pressure protection relief and hydrocarbon disposal systems
GS EP SAF 311	Rules for the selection of fire-fighting systems
GS EP STR 103	Design and fabrication of skids and equipment supporting structures

Others documents

Reference	Title
Oil and Gas Journal	(March 29, 1993)

3. General

3.1 Terminology and definitions

There are five types of statement in this specification, the “shall”, “should”, “may”, “can” and “must” statements. They are to be understood as follows:

Shall	Is to be understood as mandatory. Deviating from a “shall” statement requires derogation approved by Company.
Should	Is to be understood as strongly recommended to comply with the requirements of the specification. Alternatives shall provide the same level of protection or performance and this shall be documented.
May	Is to be understood as permission.
Can	Is to be understood as a physical possibility.
Must	Expresses a regulatory obligation

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3.2 Acronyms

BDV	Blow Down Valve
F&G	Fire and Gas
HC	HydroCarbon
LAH	Level Alarm High
LAL	Level Alarm Low
LCV	Level Control Valve
LP	Low Pressure
LSHH	Level Safety High High
LSLL	Level Safety Low Low
NLL	Normal Liquid Level
P&ID	Piping and Instrumentation Diagram
PFD	Process Flow Diagram
PSV	Pressure Safety Valve
RTD	Resistance Temperature Detector
TAL	Low Temperature Alarm
TEG	Tri Ethylene Glycol
TSHH	Temperature Safety High High
TSLL	Low Low Temperature Safety

3.3 Prevailing requirements

In case of conflict between the inquiry and order, the information included in the order prevails.

In case of conflict between different project documents, the following order of precedence governs:

- Local regulations.
- Material purchase requisition.
- This specification.
- Project-specific specifications and data sheets.
- Discipline engineer's specifications.
- Company's documents.

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3.4 Documents of reference

The package equipment and all accessories shall be designed, fabricated and tested in accordance with the specifications, codes, standards and regulations listed in the purchase requisition.

3.5 Qualifications

Deviations from this general specification shall be itemized with full details of proposed alternatives under the heading "Exemptions to Specification" in Vendor's proposal. Otherwise, it will be deemed that the equipment offered is in full accordance with the referred documents.

3.6 Site environmental conditions

The equipment shall be designed to operate satisfactorily over the entire temperature range and environmental conditions described in the project-specific specification.

3.7 Utilities

All available utilities on the field are as stated in the project-specific specification. Particular requirements regarding the quality or the battery limit conditions of utilities shall be expressed by Vendor in his technical offer.

3.8 Area classification

The equipment shall be suitable for operation in hazardous area Zone 2, Group IIB, Temperature Class T3 as a minimum. Reference is made to **GS EP SAF 216**, **GS EP ELE 011** and **GS EP INS 110**.

4. Vendor's scope of supply

Vendor's scope of supply shall include, but is not limited to, the following items.

4.1 General

- Engineering services for detailed engineering.
- Procurement activities, material and equipment supply.
- Fabrication and shop erection.
- Shop testing and services of personnel required during testing.
- Inspection, Quality assurance/Quality control.
- Spare parts for commissioning and initial start up.
- Special tools for installation and maintenance if any.
- Packing and marking.
- All documents requested in the purchase requisition which can include additional documents requested by a third party for certification.
- Pre-commissioning, commissioning and start up procedures.

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- Operating and maintenance manuals.
- Mechanical and performance guarantees.

4.2 Main equipment

4.2.1 Feed gas treatment system

The feed gas treatment system is a two stage unit located upstream the TEG contactor. It consists of 1) a knockout drum for bulk liquid removal 2) a filtration and coalescing system for fine solids and liquid droplets removal.

The scope of supply shall include at least the filter-coalescer but may exclude the knock-out drum if provided by others.

4.2.2 Dehydration column

- The gas dehydration column equipped with its internals (structured packing or trays, distributors and mist eliminators)
- All instrumentation and valving
- Insulation supports (to be provided even if no insulation material is provided)
- And insulation material if required

4.2.3 Dry gas treatment system

The dry gas treatment system consists of a filter-coalescer and a cooler. It should be provided in order to minimize glycol losses.

4.2.4 Glycol regeneration skid

Equipment for the regeneration skid shall include as a minimum:

- One flash drum.
- Two cartridge filters with isolation valves (one stand-by).
- One slipstream activated carbon filter.
- One Still Column.
- One integrated reflux condenser or one external reflux condenser with receiver drum and reflux pumps.
- One reboiler, equipped either with fire tubes or electrical bundle.
- One stripping column / one stripping gas injection point (or tie-in provision) if required.
- Rich/lean glycol heat exchanger(s).
- One surge drum.
- N+1 glycol circulation pumps (one stand-by) driven by electrical motors, equipped with necessary pulsation dampeners installed both at suction and discharge.
- One final lean glycol cooler.

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- One glycol make-up facility.
- One closed drain drum with one recycle pump.
- Two chemical injection skids (pH control, antifoam), each consisting of a chemical storage tank and a dosing pump.
- One snuffing system (for fire tube option).

The glycol regeneration unit shall be skid-mounted on steel structure, with all necessary access/maintenance platforms, stairways, handrails and walkways. Reference is made to **GS EP PVV 813** requirements.

In compliance with **GS EP SAF 228**, a drip pan shall be provided underneath the glycol regeneration skid in order to collect all spills and liquid drains. The drip pan shall be provided with a specific valved drain piped (3" minimum) to the edge of the skid at the lowest point. The drain pipe shall be terminated with a flange.

4.3 Miscellaneous

- All on-skid pipework, pipe supports and valves for process, utilities, drains, vents and relief systems and lifting equipment (beams, slings, shackles etc.) in accordance with **GS EP PVV 813** and **GS EP STR 103** requirements
- Ladders and/or platform brackets
- Adequate supports and structure to minimize piping, valves, vessels, structure and instrumentation vibration in accordance with Vendor's vibration study
- All instruments, instrument supports, instrument cabling, instrument air headers, cable and/or pipe trays, unit control panels, fire and gas detectors in accordance with **GS EP INS 110** requirements
- Internal earthing loop, lighting system and heat tracing (where necessary) in accordance with **GS EP ELE 011** requirements
- Painting of complete package
- Thermal insulation material and/or personnel protection means as necessary
- Check points for corrosion inspection through the insulation
- Lifting devices for maintenance
- Provision for fire-fighting systems as defined in the project-specific data sheet or Safety Concept

4.4 Interfaces

Vendor shall provide all materials and equipment listed in this specification (and any other item which may be considered necessary for efficient and simple working and maintenance) completely assembled and ready for hook-up.

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The interfaces at glycol package battery limits are defined as follows:

- Piping: all on-skid process and utilities pipework shall end with a flange at the skid edge.
- Electrical: reference is made to **GS EP ELE 011**.
- Instrumentation and fire and gas detection: reference is made to **GS EP INS 110**.

5. Vendor guarantees

The following items and figures shall be guaranteed by Vendor and will be recorded during a formal performance test. The test duration should be sufficient for a proper assessment of the unit performance in the long term, including solvent make-up rate and operating costs.

5.1 Treated gas water dew point

Vendor shall guarantee the water content of the treated gas for all loads between turndown and design capacity.

5.2 Design flowrates

The performance and the mechanical strength of the TEG column and the TEG regeneration skid shall be guaranteed for 110 % of the specified normal operating capacity.

A turndown ratio of 30% of the normal operating capacity shall be considered unless the project-specific data sheet requires a lower ratio.

5.3 Feed gas filter-coalescer performance

- Maximum pressure drop across the filter should be 0.1 bar in clean conditions
- Removal of 99% of solid particulates with a diameter greater than 1 micron
- Removal of 99 % of liquid droplets with diameter greater than 0.3 microns
- Liquid content of the outlet gas: 5 liters per 10^6 Nm^3 of gas or 5 ppm wt maximum

5.4 Pressure drop/Temperature increase in the contactor

The pressure drop through the glycol contactor shall not exceed 0.5 bar at design conditions.

The gas temperature increase in the glycol contactor shall not exceed 3°C for the normal glycol inlet temperature.

5.5 Glycol process losses – solvent make-up

Vendor shall guarantee the overall glycol process losses for the design conditions. The overall glycol process losses include all forms of glycol loss by entrainment and vaporisation during normal operation (liquid carry-over, TEG vapour loss in treated gas, overhead gases of flash drum and Still Column etc.) but exclude small leaks from valves, pump packing etc. and maintenance drains. Vendor shall give the breakdown of losses by entrainment and vaporisation and indicate which thermodynamic model is used to determine vapour losses.

Glycol process losses by entrainment shall not exceed 10 liters/ 10^6 Nm^3 (0.07 USG/MMSCF) for the contactor, and 4.3 liters/ 10^6 Nm^3 (0.03 USG/MMSCF) for the regeneration skid.

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Note that the dehydration column operating conditions may significantly impact the solvent consumption.

5.6 Utilities consumption

Utilities consumption (electrical power, fuel gas, instrument air, nitrogen etc.) and stripping gas flow rate (if any) shall be guaranteed for the design conditions.

6. Safety requirements

Reference shall be made to the project-specific Safety Concept document for requirements regarding the F&G and fire fighting systems.

The number of flanges on glycol piping shall be minimized.

6.1 F&G detection and fire-fighting

Reference is made to [GS EP SAF 311](#) and [GS EP INS 110](#). The TEG unit fire detectors and fixed fire-fighting equipment shall be integrated within the package boundaries. The detection signals will be transmitted to the main F&G system in the control room.

6.2 Requirements for PSV and depressurisation means

[GS EP SAF 261](#) requirements shall be adhered to.

6.3 Fire heater

In case a fire heater is selected as TEG reboiler, the number of flanges on fuel gas piping shall be minimized. Instruments on reboiler and glycol flash drum, drain points (process and instruments) and flanges shall be located as far as practicable from the combustion air intake.

Reference is made to [GS EP SAF 227](#) for requirements regarding fire heater gas detection, fire-fighting and snuffing systems.

7. Process design requirements

7.1 TEG unit basis of design

7.1.1 Feed gas water content

If the feed gas water content is not given in the project data sheet, the basis for design shall be the maximum water content (saturation) determined by one the following methods:

- The most conservative correlation based upon Vendor know-how for the project-specific conditions (shall be indicated in Vendor's proposal).
- The charts given in the latest edition of the [GPSA](#) with salinity and relative density correction (this value shall be multiplied by 1.1).
- The charts given by Wichert in [Oil and Gas Journal \(March 29, 1993\)](#) with salinity and relative density correction (this value shall be multiplied by 1.1).

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Notes:

- In all cases corrections for acid gas components shall be taken into account
- Water content shall be calculated for the most stringent operating conditions (i.e. minimum pressure and maximum temperature)

7.1.2 Treated gas dew point specification

Vendor should consider adding a 5°C margin on the guaranteed treated gas dew point value because of the penalties attached to this contractual value.

7.1.3 Glycol flow rate

The lean glycol flowrate is a function of the quantity of water to be removed and shall not be lower than the value given in Table 1 for a given raw gas water content.

Table 1 - Determination of TEG flowrate versus feed gas water content

Water content of wet gas			Lean TEG/Removed water ratio	
mg/Sm ³	kg/MMSCF (x 0.0283)	lb/MMSCF (x 0.0624)	kg/kg	USG/lb (x 0.1089)
≥ 5000	≥ 141	≥ 312	15	1.6
3000 - 5000	85 - 141	187 – 312	18	2.0
2000 - 3000	57 - 85	125 – 187	20	2.2
1200 - 2000	34 - 57	75 – 125	22	2.4
800 - 1200	23 - 34	50 – 75	25	2.7
600 - 800	17 - 23	37.5 – 50	27.5	3.0
400 - 600	11 - 17	25 – 50	30	3.3
≤ 400	≤ 11	≤ 25	35	3.8

Furthermore, to ensure sufficient wetting of the structured packing, the glycol flow rate shall not be lower than 1 m³/h/m² of dehydration column area section.

7.1.4 Lean glycol purity

The addition of a stripping column should be considered even if a low lean glycol purity is targeted. Provision for direct stripping gas injection into the reboiler shell shall be implemented for small capacity units.

The lean glycol purity and the number of equilibrium stages in the contactor shall be determined on the assumption that the feed gas is water saturated (reference is made to section 7.1.1 for water saturation method), even if the wet feed gas is not water saturated in project-specific conditions.

The required lean glycol purity for a given treated gas specification shall be determined with a margin of 10°C between the targeted water dew point and the theoretical equilibrium dew point.

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7.1.5 Material balance

A detailed material balance including all components (H₂O, TEG, high and heavy hydrocarbons, aromatics, H₂S, CO₂, etc.) shall be produced.

The break-down of expected glycol losses shall be provided: liquid carry over, vapor losses in treated gas and overhead gases of flash drum and still column, pumps leakage, etc.

7.1.6 Aromatics co-absorption

Detailed calculation for aromatics according to [GPSA](#) method shall be submitted to Company.

In the event no aromatic content is specified in the feed gas composition, Vendor shall consider for his design that aromatics components represent at minimum 10 mol% of the C₆+ cut.

Special care shall be taken for the design of the stripping column, Still Column, overhead condenser and charcoal filter to account for the presence of dissolved aromatics in the glycol solution.

7.1.7 Equipment and piping insulation and heat tracing

Reference is made to [GS EP ECP 103](#) requirements.

Heat tracing of level instruments shall be implemented if there is a risk of hydrate formation.

7.1.8 Floating units

The design and layout of TEG units installed on floating units shall take into account the motion conditions and resulting accelerations. The unit performance shall be guaranteed for the worst sea conditions.

Reference is made to [GS EP STR 103](#) for equipment support design.

7.2 Feed gas treatment system

The feed gas treatment system shall be located close to the absorber to prevent any condensation in the interconnecting piping due to pressure drop and/or heat losses. This line shall be insulated.

Suitable internals shall be selected for effective solid/gas and liquid/gas separation at project-specific conditions. Reference is made to [GS EP ECP 103](#) requirements for gas/liquid separator sizing.

As described in section 4.2.1, the feed gas treatment system has two functions which may be combined in a single vessel provided that the liquid knock-out compartment follows [GS EP ECP 103](#) sizing rules.

Although not recommended, the feed gas treatment system may be integrated at the bottom of the TEG column provided that its calculated diameter (as determined by [GS EP ECP 103](#) method) is not reduced to match required TEG column diameter.

The filter-coalescer configuration can be either horizontal or vertical. With no other information available and if not described in the project-specific specification, the filter-coalescer design shall be based on a liquid content in the feed gas of 1 m³/10⁶ Nm³ of gas or 1,000 ppm wt.

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The solid removal section and the gas removal section shall be equipped with dedicated liquid outlet nozzle and dedicated instrumentation.

No spare is required for this service, but a by-pass line and isolation valves shall be provided.

This filter should be equipped with a quick release cover with safety interlocks to prevent accidental opening under pressure. It shall be also equipped with depressurization and nitrogen inerting facilities. Provision for methanol injection should be provided on the liquid outlets.

The following instrumentation shall be implemented as a minimum:

- Level controller with automatic level control valve on liquid outlets.
- Level glasses.
- LSLI with emergency shutdown valve on the liquid outlets.
- LSHH with alarm on the upper section.
- High differential pressure gauge/alarm.
- PSV.
- One BDV (if required) or at least PSV fire case as per requirement from **GS EP SAF 262**.

7.3 Dehydration column

Regarding the type of internals, the glycol contactor is normally fitted with structured packing. Bubble cap trays may be considered instead of structured packing for certain conditions, for example an onshore plant operating at relatively low pressure.

The basis for TEG column sizing shall be 110 % of the specified normal operating capacity in order to cover potential gas flow fluctuations.

The TEG contactor shall be equipped with a feed gas distributor which can be either a deflector plus distribution tray or a vane type distributor.

The arrangement of the feed gas distributor and the top glycol distributor shall be reviewed and approved by the structured packing or bubble cap trays supplier.

The glycol surge time (LAH-LAL) in the dehydration column shall not be less than 10 minutes.

Liquid levels may be set in the bottom head with a minimum distance of 300 mm from the column bottom line.

The diameter of the column and the height of structured packing (or number of bubble cap trays if applicable) shall be calculated and confirmed by the column internals supplier.

The structured packing height shall not be less than 3 meters and six (6) bubble cap trays shall be installed at minimum if this type of internals is selected.

A mist eliminator device capable of eliminating 99.0 % of droplets larger than three microns shall be installed at the top of the dehydration column (may be a mesh pad or a vane pack or a combination of the two if required). Refer to Appendix 7.

The distance between the top of the structured packing and the mist eliminator shall be at least 1,200 mm (for insertion of a manhole). The distance between the mist eliminator and the vane pack (if any) shall be at least 400 mm.

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Any liquid collected from the vane pack (if any) shall be drained to avoid re-entrainment and foaming. Refer to Appendix 7 for more details.

Hydrocarbon condensation in the TEG column shall be prevented if required by the addition of insulation or protection against heavy rain conditions.

316L stainless steel lining up to one meter in the structured packing bed shall be provided. In presence of H₂S, the whole column should preferably be 316L SS clad. TEG column material selection shall be submitted to Company corrosion specialist for approval.

A skimming facility shall be installed inside the glycol column to remove possible hydrocarbon carried over from the upstream equipment (for example during bypass of the inlet gas filter) or condensed in the glycol contactor (retrograde condensation). Reference is made to Appendix 3.

Interface level glass shall be installed for hydrocarbon skimming operations.

The following instrumentation shall be implemented as a minimum:

- Level controller with automatic level control valve (See note).
- Level glass.
- LSL with emergency shutdown valve on the glycol outlet.
- LSHH.
- Differential pressure gauge with alarm high across the structured packing.
- PSV (at minimum PSV fire case shall be installed).
- BDV (if required): two BDV's, one upstream and one downstream of the packing bed shall be provided (refer to Appendix 3).

Note: Level control valve for glycol outlet should be preferably located on the regeneration skid to minimize vibrations.

7.4 Treated gas coalescer (optional)

Excessive solvent entrainment may affect the operation of the systems located downstream the dehydration unit. For instance, the accumulation of solvent in an export pipeline designed for a single phase service shall be avoided. The implementation of an external filter-coalescer on the contactor overhead gas should be considered in order to minimize TEG losses by entrainment.

7.5 Rich glycol loop

7.5.1 Rich TEG flash drum

The operating temperature of the rich TEG flash drum shall be maintained in the range 70 to 100°C. If necessary, one rich/lean glycol heat exchanger can be installed upstream the flash drum in order to heat up the rich TEG solution.

An impingement plate shall be installed in front of the rich glycol inlet nozzle and a vortex breaker shall be provided on the glycol outlet.

The arrangement for glycol/liquid hydrocarbon separation can be either:

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- A vertical weir. In this case, a vortex breaker shall be provided on the liquid hydrocarbons outlet.
- Or a horizontal liquid hydrocarbon collection pipe which shall be located above the TEG high high level and connected to a vertical downcomer. The two ends of the horizontal section shall be closed and several ports shall be provided on the lower part of the pipe. Total area of the ports shall be twice the area of the liquid hydrocarbon outlet nozzle.

The glycol retention time in the flash drum shall not be less than 30 minutes (NLL to bottom).

The distance between the following liquid levels shall correspond to two minutes residence time minimum at glycol nominal flowrate with a minimum value of 100 mm: NLL-LAH, LAH-LSHH, NLL-LAL, LAL-LSLL. Refer to Appendix 8.

Sizing of the glycol level control valve shall take into account the solubility of natural gas in glycol. Calculation of vaporization of all components of gas, including H₂S, CO₂, heavy hydrocarbons, aromatics, etc. should be done prior to valve sizing.

Flash drum PSV shall be sized for the largest relief rate resulting from the two following cases: 1) external fire 2) inadvertent full opening of the contactor bottom liquid level control valve and its bypass causing gas blow by. For high operating pressures, the following arrangement may be considered in order to reduce the gas blow-by flowrate and therefore the size of the flash drum PSV: two LCV's with an interlock system preventing simultaneous opening of these valves and no bypass valve.

The risk of gas blow-by through the hydrocarbon skimming system shall also be taken into account.

The mechanical design pressure of flash drum shall be at least 10 bar g.

The following equipment and instrumentation shall be included as a minimum:

- Glycol and liquid hydrocarbon level controllers with automatic control valves (See note).
- Level glasses for glycol/liquid hydrocarbon and liquid hydrocarbon/gas interfaces (See note).
- Glycol LSHH with emergency shutdown valve on the glycol inlet to avoid glycol losses.
- Two pressure control valves, one to release pressure to the flare, the other to maintain a blanketing fuel gas pressure in the vessel.
- PSV (either fire or blow-by case).
- Pressure gauge.
- Temperature gauge.
- Flow indicator with isolation and by-pass valves located on the glycol outlet piping.
- Three liquid sample connections located at the glycol/liquid hydrocarbon interface level, at plus 150 mm and at minus 150 mm.

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Note: The position of the nozzles of the level instrument shall be:

- TEG/HC liquid phases interface: one nozzle in TEG and one nozzle in HC liquid phase.
- HC liquid/gas interface: one nozzle in HC liquid phase and one nozzle in gas phase.

7.5.2 Cartridge filters

Two identical full flow cartridge filters shall be installed on the rich glycol line leaving the flash drum: one in operation, one in stand-by.

Each filter shall be designed to handle 125 % of the rich glycol nominal flowrate.

Pressure drop through the cartridge filter shall not exceed 0.1 bar in clean conditions and 0.7 bar in fouled conditions.

Filtration efficiency of cartridge filters shall be an absolute efficiency of 99 % for any particles with diameter greater than 10 microns under normal conditions.

Minimum filtration area shall be 0.2 m² per m³/h of TEG.

During commissioning activities and initial start-up, larger rating cartridges will be used. The objective is to remove 99 % of all solid particles of 25 microns and larger. At least two sets of 25 micron rating cartridges shall be supplied per filter housing as commissioning spare parts.

Each filter shall be equipped with a connected vent line with a sight flow indicator (to check if gas is trapped at the top of the filter).

The filters should be equipped with quick release covers with safety interlocks to prevent accidental opening under pressure.

The mechanical design pressure of cartridge filter shall be at least 10 bar g.

The following equipment and instrumentation shall be provided as a minimum:

- Isolation, vent and drain valves.
- PSV.
- One differential pressure gauge.

7.5.3 Activated carbon filter

One activated carbon filter shall be installed downstream of the cartridge filters with a bypass line.

This activated carbon bed shall be designed to handle a minimum of 15 % of the rich glycol nominal flow rate.

The pressure drop across the activated carbon filter shall not exceed 0.1 bar in clean conditions and 0.7 bar in fouled conditions.

Activated carbon should be packaged in cartridges in order to facilitate maintenance and to avoid activated carbon particles carry over.

The filter should be equipped with quick release cover with safety interlocks to prevent accidental opening under pressure.

The mechanical design pressure of activated carbon filter shall be at least 10 bar g.

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In case of presence of aromatics in high concentration, it may be relevant to provide a second activated carbon filter on the lean glycol loop (downstream circulation pumps or on partial pump around on the surge drum).

The following equipment and instrumentation shall be included as a minimum:

- Isolation, vent and drain valves.
- Bypass valve.
- PSV.
- One differential pressure gauge.

7.6 Glycol regeneration system

7.6.1 Still Column

The Still Column shall be fitted with two beds of 316 stainless steel random packing of one meter high each minimum with their associated liquid distributors.

Ceramic saddles are prohibited.

Insulation for heat conservation is required.

Still Column shall be made of a corrosive resistant material (SS 316L or equivalent). Still Column material selection shall be submitted to Company corrosion specialist for approval.

The design pressure of the Still Column shall be selected in accordance with maximum expected back pressure of the flare system and shall be 3.5 barg as a minimum.

A temperature gauge shall be provided on the vapour outlet line.

7.6.2 Still Column condenser

The Still Column condenser shall be sized for a minimum reflux ratio of 30 % based on the total quantity of water to be removed.

The Still Column condenser system shall be made of a corrosive resistant material (SS 316L or equivalent). Still Column condenser material selection shall be submitted to Company corrosion specialist for approval.

The design pressure of the Still Column condenser shall be selected in accordance with maximum expected back pressure of the flare system and shall be 3.5 bar g as a minimum.

The Still Column condenser can be either integrated in the column or an external system.

7.6.2.1 Integrated condenser using rich glycol stream

This solution is acceptable for low capacity units.

This Still Column integrated condenser shall be a shell and tubes heat exchanger (coil type exchanger is prohibited).

Insulation for heat conservation is required in case of heavy rain.

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The following equipment and instrumentation shall be included as a minimum:

- Upstream isolation and manual control bypass valves.
- Temperature gauges located upstream the condenser and downstream the bypass.

7.6.2.2 External condensation system

The Still Column condensation system consists of an external heat exchanger (using air or cooling water as cooling medium), a reflux drum and reflux pumps. Special care should be taken when selecting material of construction as condensed water could be corrosive.

The reflux drum should be a 3-phase separator:

- Reflux drum overhead gas shall be routed to a low pressure system, preferably the LP flare
- Recovered liquid hydrocarbon should be sent by gravity to the oily closed drain system through a siphon with all precautions taken to prevent back flow from the closed drain system. If pressure allows, a control valve should be installed.
- Condensed oily water should be pumped, partially back to the still column as external reflux through a flow control valve, the balance being routed to the oily water treatment through a level control valve.
- Reflux drum minimum instrumentation:
 - Level glass on the water side
 - LSWL on the water side to shut-off the recirculating pump
 - Temperature gauge

N+1 condenser reflux pumps shall be provided, one on duty, one stand-by. These pumps are electric motor driven centrifugal pumps and are installed complete with isolation valves, non-return discharge valve, inlet "Y" strainer and discharge pressure gauge.

7.6.3 Reboiler

The design of the glycol regeneration unit shall be based on a reboiler temperature of 204°C maximum. If possible, a lower temperature should be selected. Average heat flux across fire tube or electrical bundle wall shall not exceed 20,000 kcal/h/m² (2.3 W/cm²) at design duty. The skin temperature of the heating element shall not exceed the degradation limit of glycol, i.e. 230°C.

Reboiler design pressure shall be selected in accordance with maximum expected back pressure of the flare system and shall be 3.5 barg as a minimum.

A provision for stripping gas injection into reboiler shell should be provided.

7.6.3.1 Reboiler duty calculation

An overdesign of respectively 20 % for electrical heaters and 10% for fire tube reboilers shall be applied on reboiler normal duty at design capacity.

The reboiler duty calculation note shall be submitted to Company for review and approval and shall include the following information:

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- Rich glycol inlet temperature, Still Column reflux, ratio.
- Desorption of aromatics taken into account if any.
- Thermal losses (typically 10% of the overall duty).

The minimum reboiler duty shall be determined as specified in Table 2:

Table 2 – TEG Reboiler duty in kcal per kg of water to be desorbed

Lean TEG/Water ratio, kg/kg	15	25	35
• Fire tube (Note 1)	1,520	1,890	2,270
• Electrical	1,660	2,060	2,480

Note 1: formula for interpolation: $Q = \text{kg/kg} \times 37.5 + 957 \text{ kcal/kg}$

7.6.3.2 Minimum reboiler instrumentation

- Pressure gauge
- PSV calculated for reboiler blocked outlet and fire case
- Temperature controller
- Temperature gauge
- High temperature alarm
- TSHH
- TAL
- TSLL if requested by the gas processing
- Level glass
- LAL
- LSLL located at the top of the fire tube or electrical bundle.
- LAH
- LSLL

7.6.3.3 Preheating coils

Preheating coils can be installed in the reboiler liquid bath in order to either heat the stripping gas (if any) up to 120/150°C or to heat the burner fuel gas (if any) up to 60/80°C or both.

A drain pot, with a manual drain, shall be installed on the fuel gas inlet piping upstream the preheating coils. Insulation for heat conservation is required.

7.6.3.4 Electrical bundle

This technology is adequate for low duty reboilers.

10 % spare electrical resistances shall be installed but not connected.

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For electrical power lower than 100 kW, the temperature may be 100% controlled via thyristor power.

For higher duties, the control system should be based on a mixed system in order to avoid disturbances due to harmonics:

- n sets of resistances fed in on/off mode by means of electromagnetic contactors. These sets of resistances ensure the bulk regulation of the temperature.
- One set of resistances fed via a power thyristor. This set of resistances insures the trim regulation. Thyristor technology shall be of batched full series waves type.

The electrical heater shall be protected against the risk of overheating or damage by the following safety elements:

- One TSHH on the TEG liquid to shut-off the electrical power.
- Four high temperature switches on skin temperature of resistances: two installed on on/off fed resistances of different types (RTD and thermocouple), and two installed thyristor fed resistances. In case of one high temperature detected by one detector, the electrical heater is automatically shut off.
- LSSL.
- External ESD.

7.6.3.5 Fire tube reboiler

High capacity fire heaters shall be forced draught type. For a small reboiler duty, a natural draft burner is acceptable subject to the following conditions:

- The chimney draft shall be greater than the overall system pressure drop (from the air inlet up to the stack outlet) plus 30% minimum.
- All **GS EP SAF 227** requirements for natural draft heaters are adhered to.

Use of multi return tubes directly welded on the main tube requires Company PVV specialist's approval. Direct fired U tube type is preferred. Mitre bend both sides welded (internal, external) is acceptable.

Fire tube shall be seamless type.

Two fire tube assemblies should be preferably installed where:

- The fire tube length is longer than 10 meters.
- The fire tube diameter is greater than 24".
- Overall reboiler duty is greater than 750,000 kcal/h.

Two separate reboilers should be preferably installed for duties greater than 1,500,000 kcal/h i.e. the quantity of water to be removed is higher than approximately 800 kg/h.

Fire tube shall be properly supported and the supports shall be designed taking into account the differential expansion between the shell and the fire tube. Fire tube shall be field removable for inspection. Minimum wall thickness of the fire tube shall be 10 mm.

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To ensure that fire tube is always immersed in glycol solution, normal liquid level shall be maintained at 150 mm above the fire tube (see Appendix 9).

The thermal duty of the burner shall be at least 1.7 times the heat to be transferred to the TEG at design capacity (including the design margin defined in section 7.6.3.1).

A heat resistant firing cylinder where the flame burns shall be located in the fire tube. Tertiary air with manual tertiary air register control will flow between the cylinder and the fire tube.

A peep hole shall be provided for visual inspection of the flame pattern (main flame and pilot) within the burner and fire tube.

The vent stack shall be externally supported on an appropriate structure and fitted with a spark arrestor.

The flame detection system is either an Ultra Violet self-checking detector or an ionization rod. Flame detectors based on temperature effects are not accepted.

Reference is made to **GS EP SAF 227** for specific requirements regarding air flow and fuel/air ratio control, dampers, flame arrestors, igniters, safety equipment and shutdown logic.

7.7 Lean glycol loop

7.7.1 Stripping Column (optional)

The stripping column is fitted with one bed of 1.2 meter high minimum of 316 stainless steel random packing.

Ceramic saddles are prohibited.

The stripping column overhead gas shall be routed to the reboiler vapour space via a dedicated line and nozzle (different from the glycol inlet line and nozzle).

Insulation for heat conservation is required.

Material of construction shall be either carbon steel with 5 mm corrosion allowance or stainless steel.

The following minimum instrumentation should be provided on the stripping gas line:

- One automatic pressure control valve.
- One pressure gauge.
- One flow indicator with manual adjustable, isolation and bypass valves.
- One temperature indicator.

7.7.2 Rich/Lean glycol heat exchanger(s)

For the case with external reflux condenser, a rich/lean heat exchanger might be required upstream the flash drum in order to operate the flash drum at a temperature of 70°C minimum.

For the case with integrated reflux condenser, the glycol entering the flash drum is heated in the exchanger installed on top of the still column.

On lean glycol stream, heat exchangers may be located between the stripping column and the surge drum, or between the surge drum and the injection pumps.

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Rich/lean glycol heat exchanger type should be welded stainless steel plate heat exchangers. Plate and gasket heat exchangers are prohibited due to potential leaks during transient operations.

An over design of 25 % extra heat transfer area shall be considered for fouling.

Insulation for heat conservation is required.

One temperature gauge shall be located on each of the heat exchanger inlet and outlet (4 in total).

7.7.3 Surge drum

The surge drum (see Appendix 8) shall be sized on the following basis:

- LSSL is not lower than 200 mm above the lowest point of the shell or 30 seconds on glycol flow rate, whichever is the highest.
- The glycol volume between (LAL-LSHH) is at least 3 days of estimated consumption of the whole glycol package unit (1) or 100 mm.
- The glycol volume between the low level and high level alarms (LAL-LAH) is at least 15 days of estimated consumption of the whole glycol package unit (1).
- If not specified in the project-specific specification, it shall be possible to store the TEG inventories of the reboiler plus the glycol dehydration column (considered at working temperatures) in the surge drum between LAH and LSHH.

Note 1: Estimated consumption/make-up rate based on 1 I/MMSCF (35.4 I/10⁶ Sm³) or guaranteed value whichever is the highest.

The following instrumentation should be provided as a minimum:

- Level glass.
- LAL.
- LSSL.
- LAH.
- LSHH.

7.7.4 Glycol circulation pumps

The Vendor shall supply n+1 pumps ((one stand-by).

The Vendor shall be responsible for the design, manufacture, assembly, supply of drawings and data, co-ordination with Sub-Vendors, inspection, testing requirements for the supply of the Positive Displacement Pumps - Reciprocating driven by electrical motors as per [API 674](#) and covered by [GS EP MEC 028](#). This document is detailing the scope of supply and the associated design rules requested by Total E&P for the procurement of the here above referenced equipment.

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7.7.5 Final lean glycol cooler

On one side, the lean glycol temperature should be as low as possible to enhance water absorption and to reduce glycol losses. On the other side, the lean glycol temperature should be higher than the dry gas temperature by at least 5°C in all operating conditions to avoid hydrocarbon condensation and foaming conditions in the column.

10% of extra surface shall be provided as margin for fouling.

One temperature gauge should be provided on the TEG outlet line.

The cooling medium for the final lean glycol cooler can be either dry gas, soft cooling water or air. Sea water shall not be used due to potential fouling and corrosion issues.

7.7.5.1 Dry gas/Llean glycol heat exchanger

This heat exchanger is shell and tube type installed vertically on the dehydration column.

This solution is technically acceptable where there are no limitations on the gas pressure and the gas temperature.

7.7.5.2 Cooling water/Llean glycol heat exchanger

Soft cooling water can be used. One differential temperature controller (between water and lean glycol temperatures) should be provided with temperature control valve located on the cooling water network.

7.7.5.3 Air cooler

This solution is technically acceptable and should be used where dry gas or soft cooling water cannot be used. Reference is made to **GS EP PVV 415**.

The thermal rating shall be determined by the Vendor with due consideration for potential hot air recirculation.

Air temperature indicated in basis of design corresponds to still air in open space. Consideration shall be given to proximity of reboiler, chimney hot equipment, possible recirculation of hot air, additional radiations from surrounding reflecting surface.

Exchangers shall be designed for 110 % of the maximum specified process flow conditions. The Vendor shall ensure that the specified heat duty includes this extra 10 % and shall state this clearly on the data sheet.

In anticipation of fouling and possible damage to fins, the rating of the motor and the corresponding point on the fan characteristic performance curve shall each be advanced by a factor of 1.2 times the air side pressure drop over the bundle. The motor rating calculated shall be checked for the condition at the specified minimum air temperature.

Turbulators in lean glycol air cooler are acceptable.

Additional minimum instrumentation: one differential temperature controller (between air and lean glycol temperatures) with temperature control actuating the louvers of the air cooler or a control by-pass valve.

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7.8 Miscellaneous

7.8.1 Fresh glycol make-up facilities

Fresh glycol make-up facilities consist of:

- One glycol storage tank.
- One glycol make-up pump to fill the surge tank.

Fresh glycol storage tank (preferably installed, refer to data sheets):

- Size: two weeks of estimated TEG consumption of the whole glycol package (refer to note 1 § 7.7.3)
- Minimum instrumentation:
 - Level gauge
 - Blanketing with fuel gas: one PCV to pressurize the tank, one PCV to release the pressure to the flare
 - One PSV

Fresh glycol make-up pump:

- Electric motor driven centrifugal pump with local ON/OFF pushbutton, or pneumatic pump manually operated
- Complete with isolation valves, discharge non-return valve
- To avoid too large flow of cold glycol to the hot surge drum, a manual flow control valve is provided with a pump mini flow

One solid particle filter to be installed at the pump discharge. Glycol filtration: For gas with a high aromatic content, it is recommended to treat part of the regenerated glycol (without aromatics) into the charcoal filter by using the make-up pump, refer to Appendix 6.

7.8.2 Closed drain facilities

These facilities should be preferably installed to avoid pollution of the oily water treatment by the glycol. Reference is made to **GS EP SAF 228**. The closed drain facilities should include the following:

- One closed drain storage tank to recover drains from the pumps, the filters and the level instruments if required.
- One recirculating pump to empty the drain storage tank into the surge drum.
- Closed drain storage tank minimum instrumentation:
 - Level gauge
 - One PSV
 - One vacuum relief valve

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- Recirculating pump:
 - Electric motor driven centrifugal pump
 - Complete with isolation valves, discharge non-return valve, upstream filter

8. Layout and access requirements

Reference is made to **GS EP PVV 813** and **GS EP STR 103**.

The design and layout of the package shall take into account the need for regular maintenance.

Equipment and piping arrangement shall be adequate for safe access for operation, maintenance and component removal for equipment, tube bundles, valves and controls.

For this purpose, safe access ladders, platforms and railings shall be provided according to the project standard.

With reference to **GS EP SAF 216**, the maximum temperature of any non electrical equipment under normal operating and abnormal conditions, shall not exceed 200°C. This requirement can be met either by construction or by applying thermal insulation. Glycol reboiler external hot parts (T > 200°C) shall be heat insulated (as gas tight as practicable) even if they are not located in a hazardous area as they are in a restricted area.

Platform, ladders, railing, piping, etc., shall be removable where required for shipping, installation, and major maintenance.

Drip pans and trays shall be integral with the skid, such that under no circumstance, can glycol/hydrocarbon liquids be spilled into the surrounding areas.

The skid shall be provided with integrated drip pans and they shall have sloped bottoms and flanged drain nozzles(s) at the edge of the base frame.

The Vendor shall avoid protrusion of piping, structural, electrical and instrument installation outside the boundary limits of the package. Where design or drawings incorporate such protrusions, the Vendor shall provide adequate temporary supports and/or protection devices as necessary to prevent any damage of such items during transportation, lifting or installation. Where specified on the drawings, protrusions such as platforms and stairways shall be removable type.

Grating shall be provided where personnel access is required for operation and regular maintenance.

Lifting pads shall be installed for skid handling.

9. List of deliverables

9.1 Process information to be included in tendering documentation

- Duly filled technical bid tabulation sheet (refer to Appendix 1)
- PFD's
- P&ID's
- List of qualifications/deviations to this specification if any

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- Layout with main dimensions
- Detailed material balance including aromatics breakdown
- Material selection diagram
- Equipment data sheets with details of vessel internals and fouling factor for exchangers
- Glycol purity/flow rate
- Process calculation notes (raw gas water content, glycol purity and flow rate, gas velocity in contactor, etc.)
- Maximum guaranteed glycol losses in the contactor and in the regeneration package
- Number of theoretical trays or height of packing in the glycol contactor and still column
- Reboiler duty, heater surface temperature, heat flux and any allowance made for fouling of heaters
- Vendor calculation/data sheets for exchanger, air cooler and pumps
- Turndown rate of glycol contactor
- Foaming factor used for TEG column sizing
- Utility consumption (normal and peak rates) including electrical power, fuel gas, cooling water, instrument air, chemical product, etc. Individual motor horsepower ratings shall be provided
- Reference list for similar units

9.2 Process documents for Company approval during detailed engineering

- All tender documents re-issued for approval
- Logic diagrams
- Estimated glycol inventory of the system
- Calculated and required NPSH for the glycol pumps
- Reboiler burner calculation note
- Dimensional drawings showing plans and elevations of all equipment and components on the glycol contactor and regeneration package and location of piping / electrical / instrumentation terminations on the contactor and the package
- Interface documentation including all connection details

9.3 Final documentation

- All documents listed here above
- Vendor's catalogue data of major equipment including pumps, exchangers, filters, etc.
- Operating and maintenance manual



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Bibliography

Reference	Title
Campbell	Gas Conditioning and Processing Vol.2 : The Equipment Modules Chapter 18

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Appendix 1

Appendix 1 Technical evaluation

Process evaluation	Unit	Targeted value	Vendor data	Comment
General data				
Gas Flow rate				
Nominal	MMSCFD			
Design	% nominal			
	MMSCFD			
	Nm ³ /h			
	kg/h			
Turndown	% nominal			
Gas temperature (maxi)	°C			
Gas pressure (mini)	Barg			
Gas density	kg/m ³			
Water content				
• Feed	kg/MMSm ³			
• Export	kg/MMSm ³			
Water to be removed				
Normal	kg/h			
Design	kg/h			
Glycol				
Mini. Flow rate	kg/kg water			
Lean glycol flow rate	kg/h			
Process data				
Glycol nominal circulation rate	m ³ /h			
Purity of lean glycol prior to stripping	%			
Purity of lean glycol after stripping	%			
Purity of rich glycol	%			
Stripping gas rate	scf/gal lean TEG			
Aromatic flow rate (reflux drum outlet)	kg/h			

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Appendix 1

Process evaluation	Unit	Targeted value	Vendor data	Comment
Guaranteed values				
Treated gas water dew point	°C			
Total process glycol losses	I/MMSCF	0.38		
Inlet gas filter:				
• Solid filtration efficiency		99 % at 1µm		
• Liquid content in outlet gas	ppm wt	5		
Contactor pressure drop	Bar	< 0.5		
Temperature increase in contactor	°C	< 3		
Fuel gas consumption				
• Stripping	MMSCFD			
• Burner	MMSCFD			
Electrical power	kW			
Instrument air	Nm ³ /h			
Equipment data				
Feed gas filter/coalescer				
Diameter x Length	m x m	-		
Pressure drop (clean)	Bar	0.1		
Glycol contactor				
Gas velocity	m/s			
Diameter x height	m x m			
Packing height/nb of tray	M			
Packing type/tray type		Mellapak 250Y or equivalent		
Top vane pack area	m ²			
Top mesh pad area	m ²			
Distance packing/vane pack	M			
Distance vane pack/mesh	M			
Top mist eliminator efficiency				
316L cladding height (from bottom)	M			
Skimming device	-	Yes		
Max. glycol carry over in contactor	USG/ MMSCF	0.07		
Regeneration skid				
Flash drum				
H or V		H		

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Appendix 1

Process evaluation	Unit	Targeted value	Vendor data	Comment
Diameter x length	m x m	-		
Pressure (operating)	Barg	3 - 5		
Pressure (design)	Barg	10		
Temperature op/design	°C	90/105		
Baffle or inside skimming device		B		
Volume	m ³			
Corrosion Allowance (CA)	Mm			
Cartridge Filters				
Design flow rate	% nominal	125 % glycol		
Delta P clean/dirty	Bar	0.1/0.7		
Filtration area	m ² /m ³ glycol	0.2		
Particle to be removed	Micron	99 % >10 µm		
Diameter x length	m x m			
Cartridge size/number				
Design pressure	Barg			
Insulation				
Activated carbon filters				
Design flow rate	%	15 % glycol flow		
Pressure drop clean/dirty	Bar	0.1/-		
Design pressure	Barg	10		
Insulation		Yes		
Diameter x length	m x m			
Volume	m ³			
Still Column				
Diameter x height	m x m	-		
Bed 1 height/bed 2 height	m/m	1/1		
Packing type		PALL rings or equivalent		
Material		SS		
Design pressure	Barg	> 2		
Insulation		Yes		
Still Column Condenser				
Reflux ratio	% prod. water	30 %		
Material		SS		

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Appendix 1

Process evaluation	Unit	Targeted value	Vendor data	Comment
Design pressure	Barg	> 2		
Duty	Gcal/h			
Temperature in/out	°C			
Integrated or external		ext.		
Area	m ²			
Length x width	m x m			
Motor installed power	kW			
Reflux Drum				
H or V		H		
Baffle		Baffle		
Design pressure (barg)		2		
Material		SS		
Diameter (OD) x Length (TT)	m x m			
Volume	m ³			
CA	Mm			
Reflux pumps				
Nb.		2		
Flow rate	m ³ /h			
Pressure drop	Bar			
Temperature	°C			
Power	kW			

Glycol package unit

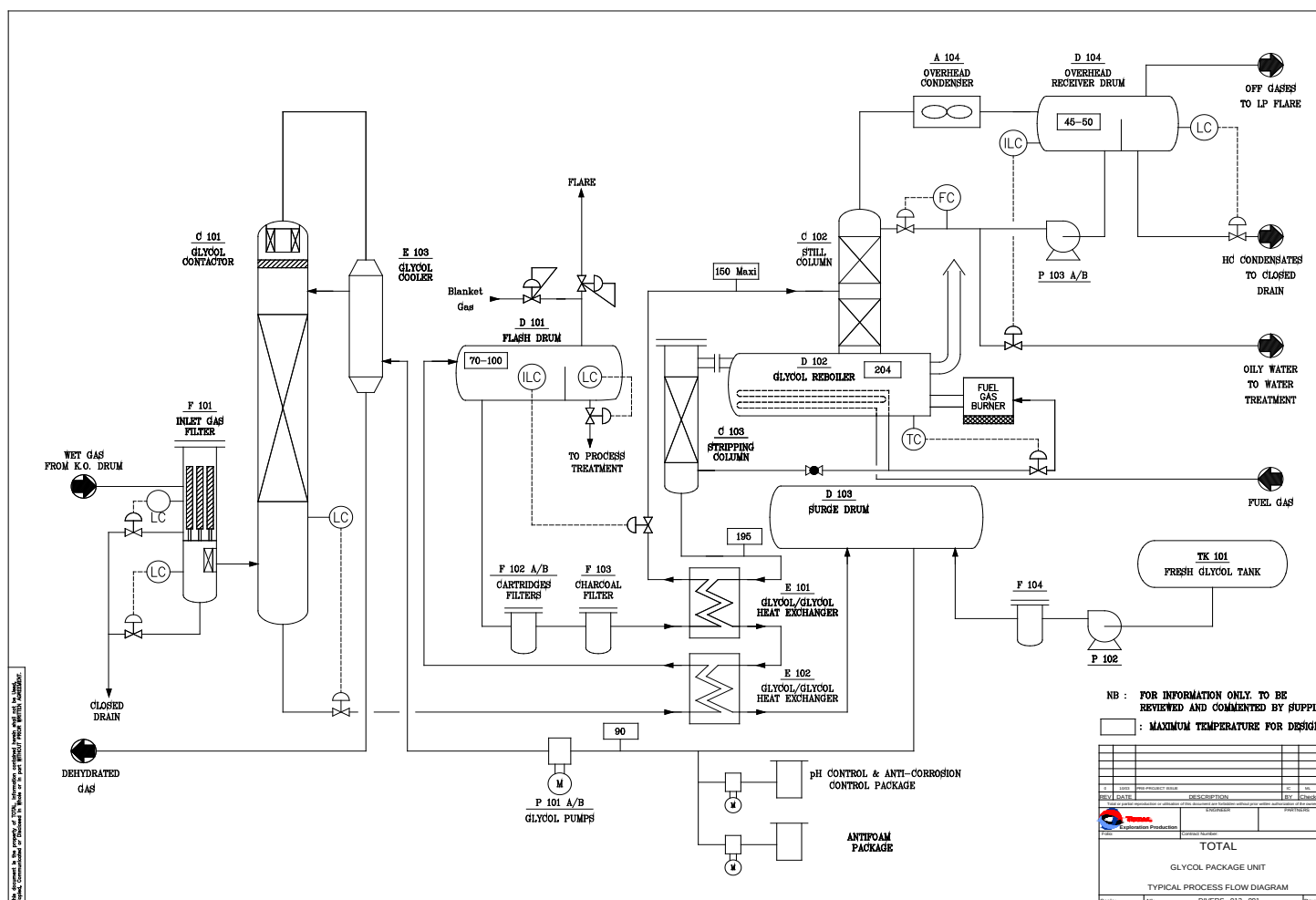
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Appendix 2

Appendix 2 Typical Process Flow Diagram of glycol package unit



Glycol package unit

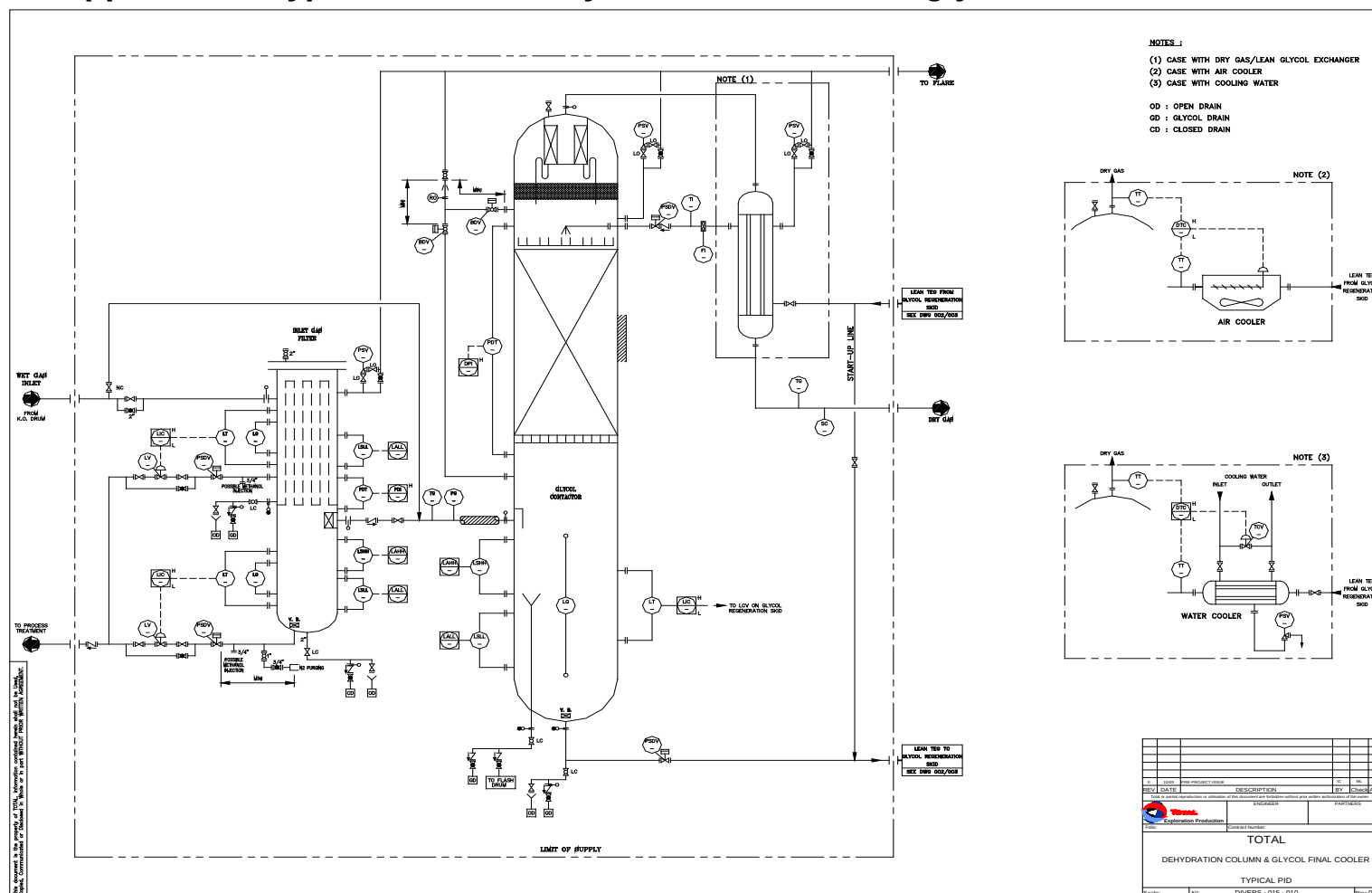
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Appendix 3

Appendix 3 Typical P&ID of dehydration column and glycol final cooler



Glycol package unit

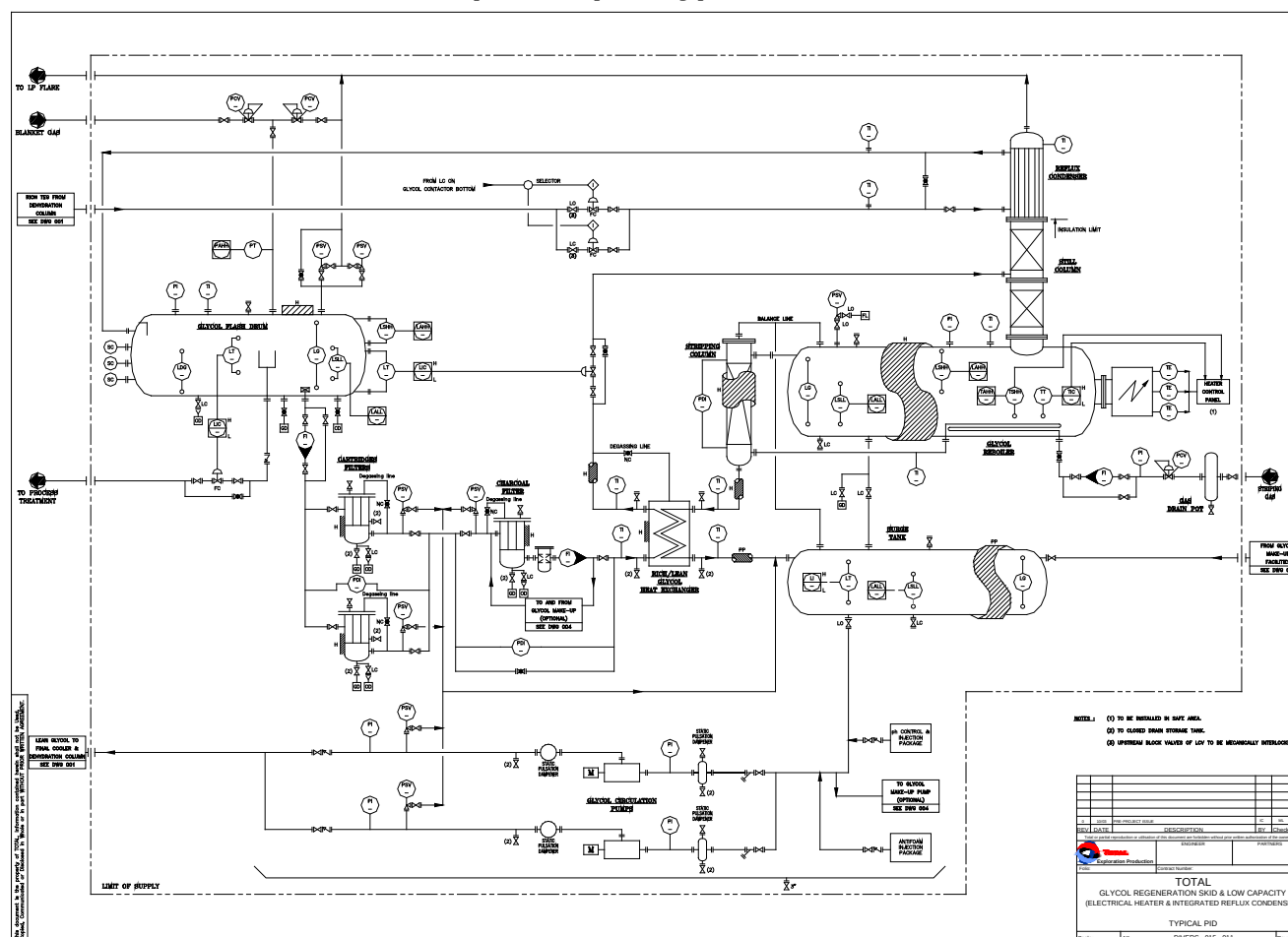
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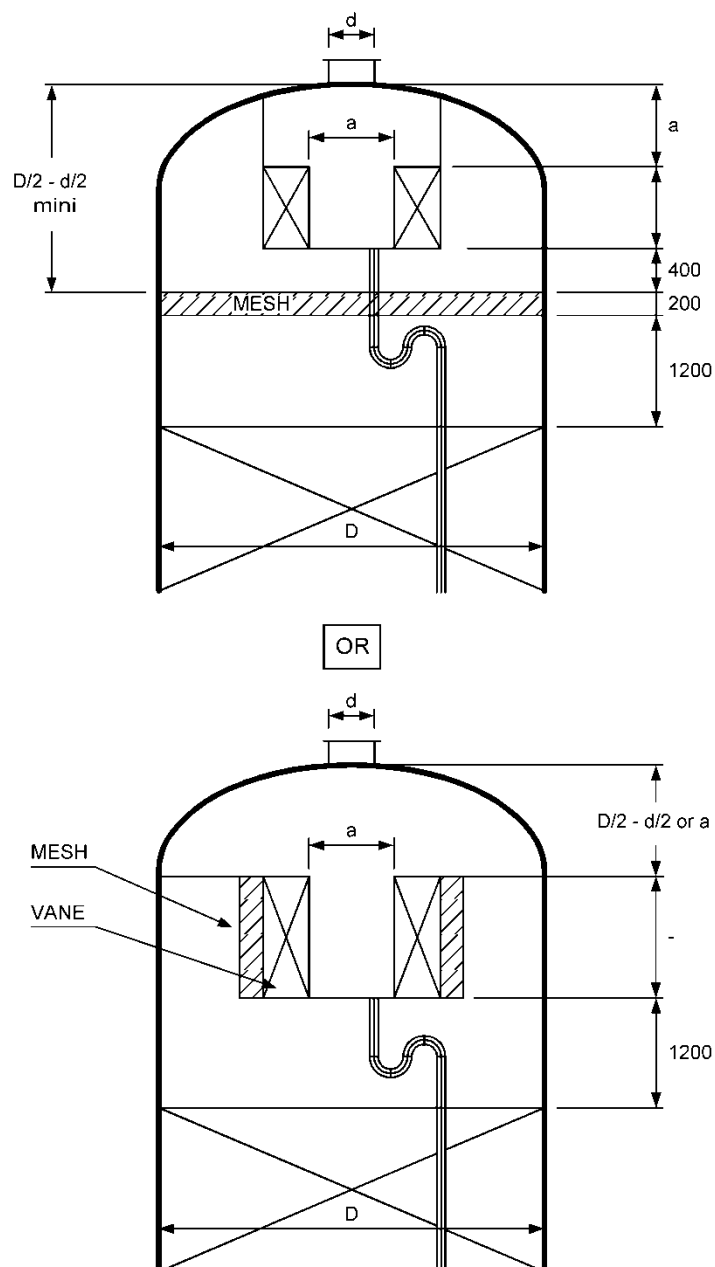
Appendix 4

Appendix 4 Typical P&ID of glycol regeneration skid (low capacity)



Appendix 7 Recommended contactor top arrangement

All dimensions are in mm.



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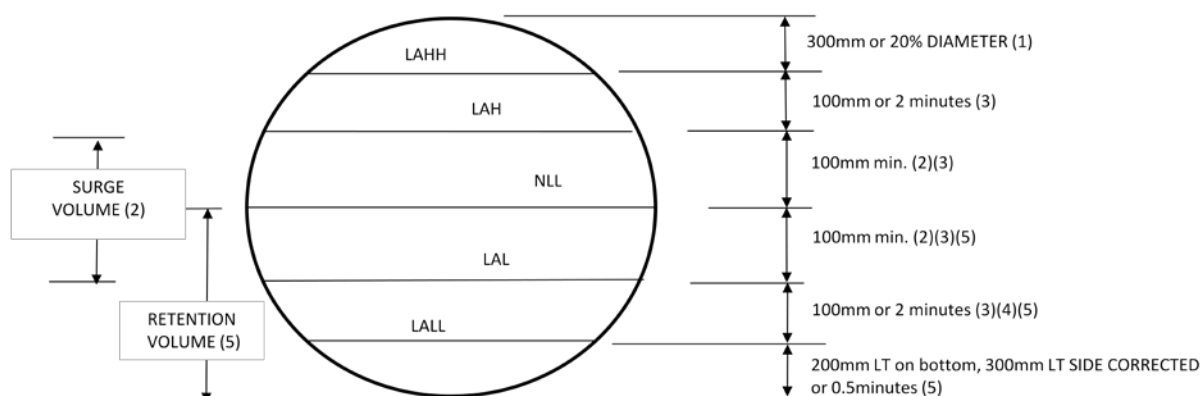
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Appendix 8

Appendix 8 Liquid levels in drums

- FLASH DRUM
- REBOILER
- SURGE DRUM
- REFLUX / OVERHEAD DRUM



NOTE 1: EXCEPT FOR SURGE DRUM: 300 mm minimum

NOTE 2: Surge capacity (LAH-LAL):

- REFLUX / OVERHEAD DRUM: 2 minutes on product to drain/storage plus 5 minutes on reflux

- SURGE DRUM: 15 days of consumption

NOTE 3: FOR REBOILER, minimum distances could be reduced to 75 mm (refer to Appendix 9)

NOTE 4: LAL - LALL in SURGE DRUM: 150 mm minimum or 3 days of consumption

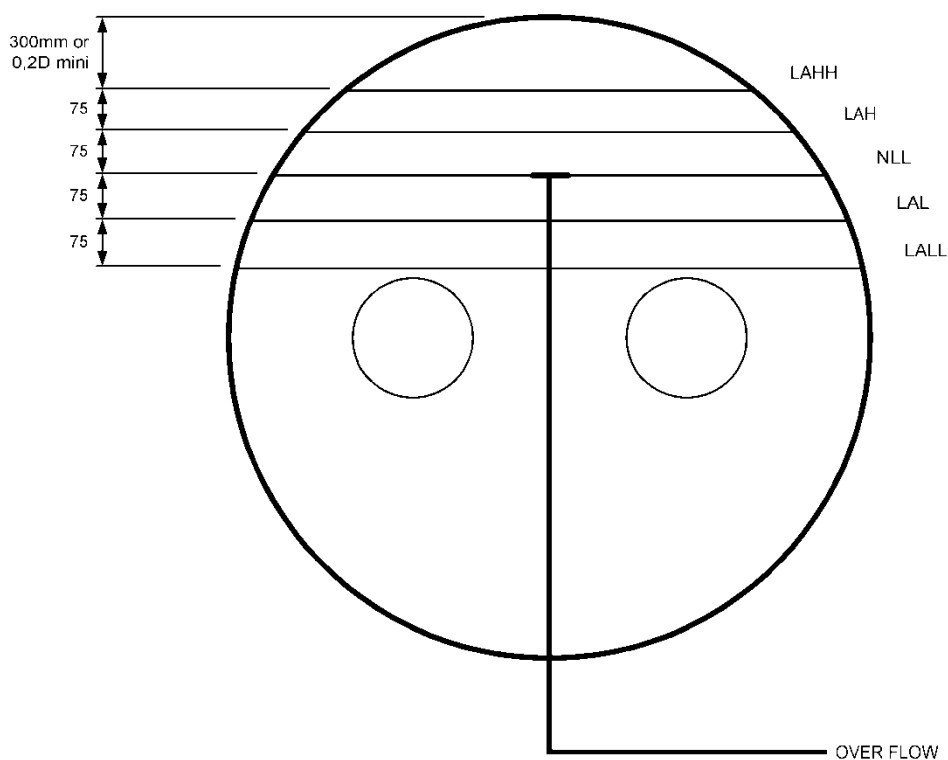
NOTE 5: Retention time in FLASH DRUM (NLL-bottom): 30 mn minimum in order to ensure proper degassing

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Appendix 9
Appendix 9 Liquid levels in reboiler


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