

Specification for Glycol-Type Gas Dehydration Units

API SPECIFICATION 12GDU (SPEC 12GDU)
FIRST EDITION, DECEMBER 15, 1990

American Petroleum Institute
1220 L Street, Northwest
Washington, DC 20005



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SECTION 1 SCOPE

1.1 Coverage. This specification covers the minimum requirements for materials, design, fabrication and testing of a conventional lease glycol type gas dehydration system utilizing triethylene glycol as the desiccant. Conventional systems are normally designed to operate at an inlet temperature between 60°F and 120°F and at or above 400 psig pressure but not to exceed pressure limited by ANSI B16.5 Class 600 flanges. This specification encompasses a system which includes an inlet separator, a glycol/gas contractor, gas/glycol heat exchanger, glycol reboiler, glycol surge tank, glycol circulating pump(s), filter(s), glycol/glycol heat exchanger, glycol flash separator (optional) and skid(s). While this specification does not preclude dehydrators for service on offshore platforms, it should be noted that considerable additional requirements may apply to offshore units.

The manufacturer of the completed glycol type dehydration unit shall be responsible for assuring that all material, design, fabrication procedures, examinations, inspections, and tests required by this specification have been met.

Appendix A through H, Section 2, and Section 3 of this specification are for information only and are not to be considered as mandatory.

1.2 Referenced Documents. Industry Codes, Specifications and Recommended Practices are referenced and

as applicable, become requirements of this specification. The latest editions and revisions of the specification, and the referenced industry codes, specifications, recommended practices and other requirements current at the time of manufacture should be considered applicable at the time of manufacture of glycol type gas dehydration units. Referenced documents may be obtained from the following sources.

- ANSI:** American National Standards Institute, 1430 Broadway, New York, NY
- API:** American Petroleum Institute, Production Department, 2535 One Main Place, Dallas, Texas 75202-3904
- ASME:** American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017
- ASTM:** American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103
- AISC:** American Institute of Steel Construction, Inc., 400 N. Michigan Ave., Chicago, IL 60611
- NACE:** National Association of Corrosion Engineers, P.O. BOX 218340, Houston, TX 77218
- TEMA:** Tubular Exchanger Manufacturers Association, New York, NY 10017

SECTION 2 TERMINOLOGY

2.1 Absorption Process. The attraction and retention of vapors (water) by liquids (glycol) from the gas stream.

2.2 Actual Tray. The number of trays installed in a column or the equivalent number of actual trays for a packed column. The number of actual trays is equal to the number of theoretical trays divided by the overall tray efficiency.

2.3 Bubble Cap Tray. Horizontal plate holding bubble caps and downcomers in the contactor.

2.4 Bubble Caps. Slotted metal caps attached over elevated nozzles (risers) on the bubble cap trays. The slots cause the gas to break up into small bubbles for intimate contact with the glycol.

2.5 Condensate. Light liquid hydrocarbons.

2.6 Contactor (or Absorber). A vertical pressure vessel where gas and glycol are intermingled counter-currently to remove water vapor from the gas. The contactor usually contains bubble cap trays, valve trays or packing.

2.7 Dehydration. Removal of water vapor from a gas. Maximum water content of the dehydrated gas is normally 7 lbs. $H_2O/MMSCF$.

2.8 Design Pressure. The pressure used in the design of a vessel for the purpose of determining the minimum permissible thickness or physical characteristics of the different parts of the vessel. When applicable, static head shall be added to the design pressure to determine the thickness of any specific part of the vessel.

2.9 Dew Point. The temperature at which vapor begins to condense into a liquid at a particular system pressure. A natural gas stream exhibits both a hydrocarbon and water dew point.

2.10 Dew Point Depression. The difference in water dew point temperature between the inlet and outlet gas.

2.11 Downcomer. The vertical conduit between trays which allows liquid to pass from tray to tray.

2.12 Firetube. The firetube is that portion of the firebox in contact with the liquids. Natural gas or hydrocarbon liquids are normally used to fire the reboiler through a submerged furnace chamber called the firetube. The firetube normally consists of one or more U-tubes fired at one end and exhausting through a vertical stack at the other end for each U-tube.

2.13 Free Water. Liquid water which is not dissolved or emulsified with any other substance.

2.14 Gas/Glycol Heat Exchanger. A shell-and-tube, pipe-in-pipe, or other type heat exchanger employed to cool the lean glycol with the gas leaving the contactor before the glycol enters the contactor.

2.15 Glycol. A liquid desiccant used to absorb water vapor from the gas. Triethylene glycol is the most common glycol used in gas dehydration.

a. Lean Glycol (or Dry Glycol). Glycol that has been regenerated and is essentially free of water.

b. Rich Glycol (or Wet Glycol). Glycol that has absorbed water.

2.16 Gas-Condensate-Glycol Separator (Flash Separator). A two or three phase separator which is used in the rich glycol stream to remove entrained gas and hydrocarbon liquids.

2.17 Glycol/Glycol Heat Exchanger. A shell-and-tube, plate type, double pipe, internal coil within the surge tank or other type heat exchanger employed to recover heat from the outgoing hot lean glycol from the reboiler and preheating the incoming cool rich glycol from the contactor.

2.18 Heat Density. This term is commonly applied to the heat release through the cross section of the firetube, expressed as BTU/hour/square inch of cross sectional area.

2.19 Heat Duty. Heat absorbed by the process, expressed as BTU/hr.

2.20 Heat Flux. The average heat transfer rate through the firetube, expressed as BTU/hr./square foot of exposed area.

2.21 Inlet Scrubber. A separator which removes free liquids from the inlet gas stream. This separator may be separate or integral with the contactor and contains a mist extractor which is usually a wire mesh type.

2.22 Intake Flame Arrestor. A device placed on the air intake of the firetube to prevent propagation of flame from inside the firetube to the outside atmosphere. It normally consists of a corrugated aluminum cell mounted in a metal housing which attaches to the firebox.

2.23 Liquid Seal. A liquid column in the downcomer that forces the gas to pass up through the trays rather than up the downcomer.

2.24 MMSCF. One million standard cubic feet of gas. One SCF is a cubic foot of gas at standard conditions specified, for example 60°F and 14.65 psia.

2.25 Maximum Allowable Working Pressure (MAWP). The maximum gage pressure permissible at the top of a vessel in its operating position for a designated temperature. This pressure is based on calculations for every element of the vessel using nominal thicknesses less allowances for corrosion and thickness required for loadings other than pressure. It is the basis for the pressure setting of the pressure relieving devices protecting the vessel.

2.26 Operating Pressure. The pressure at the top of a pressure vessel at which it normally operates. It shall not exceed the maximum allowable working pressure and it is usually kept at a suitable level below the setting of the pressure relieving devices to prevent their frequent opening.

2.27 Packing. "Rings," "saddles" or other shaped pieces in the contactor, still column or reboiler stripping column that provides a large surface area for intermingling liquid and vapor during absorption or distillation.

2.28 pH. Measure of acidity of a liquid on a scale of 0-14 with 7 being neutral. 0-7 is acidic and 7-14 is alkaline.

2.29 Reboiler (Reconcentrator/Regenerator). The vessel where water is boiled out of the glycol.

2.30 Reflux. Term given to the process of partially condensing still column vapor and allowing the condensed liquid to flow back down the column.

2.31 Removable. Total component is field replaceable without welder assistance.

2.32 Saturated Gas. A gas stream which contains the maximum amount of water vapor at a given temperature pressure without condensing the water.

2.33 Sparging Tube. Internal pipe in the reboiler used to distribute stripping gas.

2.34 Still Column (Reflux Column). Vertically mounted fractionation column on top of the reboiler.

2.35 Stripping Column. Packed column where glycol from the reboiler flows downward while gas is flowing upward stripping the glycol of water.

2.36 Stripping Gas. Gas that is passed through glycol being regenerated to help remove water that can not be removed by the distillation process alone. Sparging tubes and stripping columns are two methods of gas stripping.

2.37 Surge tank. Reservoir for regenerated glycol which may be integral with or separate from the reboiler.

2.38 Theoretical Tray. One in which the vapor leaving the tray is in equilibrium with the liquid leaving. Both leave the tray at the same pressure and temperature.

2.39 Tray Efficiency. The ratio between the number of theoretical and actual trays.

2.40 Valve Tray. Horizontal plate holding valves and downcomers in the contactor. A valve consists of a lift-able metal plate which covers a hole in the tray, providing a variable area for gas flow.

2.41 Water Content. The amount of water vapor contained in the gas expressed in pounds of water per million cubic feet (MMSCF) of gas.

2.42 Water Vapor. Water in a gaseous form.

SECTION 3 PROCESS DESCRIPTION

3.1 General. A natural gas stream can be dehydrated by contacting the gas with glycol. This process (see Figure 3.1) is normally carried out at an elevated pressure in a vessel called a contactor or absorber. After absorbing the water, the glycol is reconcentrated by boiling off the water at atmospheric pressure in a regenerator. A pump is used to recirculate the glycol to the contactor.

3.2 Inlet Scrubber. An inlet scrubber is required, either integral with the contactor or as a separate vessel upstream, to remove free liquids from the gas stream going to the contactor. The mist extractor in this vessel removes larger droplets entrained in the gas.

3.3 Contactor. The contactor vessels may be categorized as to the manner in which the absorption process is accomplished. One type uses trays equipped with bubble caps, valves, other devices, to maximize gas-to-glycol contact. The action of the gas flowing upward through the glycol layer on each tray creates a froth above the tray, where most of the absorption takes place. The other type of contactor is referred to as a packed tower. It is filled with packing, which has a large surface area per unit volume. Glycol flowing downward wets the entire packing surface. Absorption takes place as the gas flows upward through the packing, contacting the wetted surface. In either type of vessel, a mist extractor removes entrained glycol droplets from the dehydrated gas stream before it leaves the top of the contactor. On larger units, an optional residue gas scrubber may be justified. Rich (wet) glycol is directed from the bottom of the contactor to the regeneration system.

3.4 Gas/Glycol Heat Exchanger. Absorption is improved with lower temperature glycol. A gas/glycol heat exchanger is required which uses dehydrated gas to cool the lean (dry) glycol before it enters the top of the contactor.

3.5 Regeneration System. The regeneration system consists of several pieces of equipment. If glycol-gas powered pumps are installed, energy from the high pressure rich glycol along with a small amount of gas is used to pump the lean glycol. If an optional reflux coil in the still column is provided, the rich glycol flows through it before entering the glycol/glycol heat exchanger. The glycol/glycol heat exchanger serves two

purposes: 1) to cool the lean glycol to a temperature as recommended by the pump manufacturer, and 2) to conserve energy by reducing the heat duty in the reboiler.

3.6 Gas-Condensate-Glycol Separator. A frequently used option in regeneration systems is a gas-condensate-glycol separator, and should be included when the inlet gas contains condensate. It may be located upstream or downstream of the glycol/glycol heat exchanger and usually operates at a pressure of 25-75 psig. It removes condensate from the glycol prior to the reboiler, which minimizes coking and foaming problems. The separator also captures flash gas that is liberated from the glycol and exhaust gas from the glycol-gas powered pumps, so that the gas may be used as fuel. Glycol is regulated from the separator to the reboiler by means of a level controller and dump valve. Condensate removal may be controlled automatically or manually.

3.7 Reboiler. Rich glycol enters the reboiler through the still column. It is then heated to 350-400°F, which causes the water that was absorbed in the contactor to vaporize. The reboiler is usually heated by combustion of natural gas, but may utilize other fuels, steam, hot oil or other heat sources. The regenerated lean glycol gravity feeds from the reboiler, through the glycol/glycol heat exchanger, and into the pump suction for recirculation back to the contactor. Either electric, gas-powered, or glycol-gas powered pumps may be used.

3.8 Still Column. Water and glycol vapors from the reboiler enter the bottom of the still column, which is mounted on top of the reboiler. The bottom section contains packing, while the top section of the still column may contain a reflux coil or external fins. Reboiler vapors are cooled and partially condensed to provide reflux, which improves the separation between glycol and water. The remaining water vapor leaves the top of the still column and vents into the atmosphere.

3.9 Filters and Strainers. Regeneration systems contain various types of filters and strainers. A particle filter or fine mesh strainer is required to protect the pump. To reduce foaming, an activated carbon filter may be installed to remove heavy hydrocarbons from the glycol. There is no standard arrangement for these items in the system.

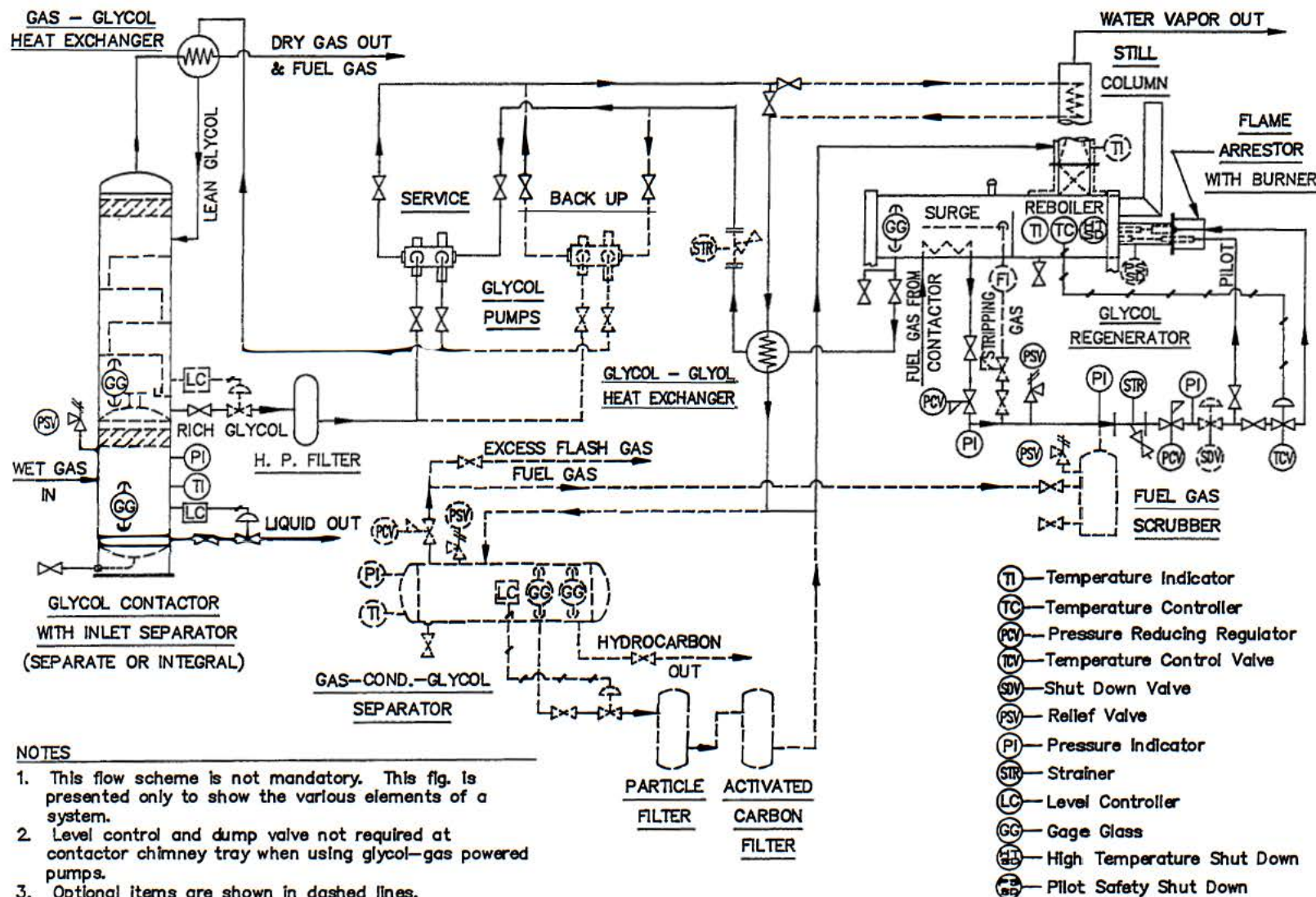


FIG. 3.1
TYPICAL SCHEMATIC FLOW DIAGRAM
GLYCOL TYPE GAS DEHYDRATION UNIT

SECTION 4 MATERIAL

4.1 General. The materials acceptable for use in construction of glycol type gas dehydration systems are given in this section. The specification and identification of materials by the manufacturer shall comply with the requirements given by the specific code or standard under which the material is used in fabrication. Materials of unknown specifications or those not meeting the requirements of the applicable code shall not be used. Material shall be marked and be identifiable at the time of fabrication. Materials given are to be considered as the minimum qualities of their kinds and such specifications do not exclude the use of any other material acceptable to the ASME, ANSI, TEMA, or ASTM code or standard under which the material is fabricated.

Pressure retaining components exposed to corrosive gases such as carbon dioxide and hydrogen sulfide shall meet the requirements as specified by the purchaser (See Appendix B for guidelines).

4.2 Pressure Vessels. Materials used in the fabrication of pressure vessels shall comply with the requirements of the latest edition of the ASME Boiler and Pressure Vessel Code Section VIII, Division 1.

4.3 Pipe Heat Exchangers. Materials used in the fabrication of pipe heat exchangers shall comply with the requirements of the latest edition of the ASME Boiler and Pressure Vessel Code Section VIII, Division 1.

4.4 Plate Heat Exchangers. Specification and identification of materials used shall be stated and shall comply with the Manufacturer's standard which defines the pressure-temperature rating marked on the plate heat exchanger and described in the Manufacturer's literature.

4.5 Shell and Tube Heat Exchangers. Material used shall comply with the requirements of the Standards of Tubular Exchanger Manufacturers Association and the ASME Boiler and Pressure Vessel Code Section VIII, Division 1. The application of the ASME Boiler and Pressure Vessel Code Section VIII, Division 1 stamp is required.

4.6 Structural. Specification of load bearing skid and other structural materials is to conform to ASTM A-36.

4.7 Piping. Piping is to be steel. Specification and identification of piping components, including flanges, fittings, and gaskets, shall comply with the appropriate standard given in ANSI 31.3 (see Table 326.1).

4.8 Proprietary Parts. Specification and identification of proprietary parts shall comply with the Manufacturer's standard which defines the pressure-temperature rating either marked on the part or described in the Manufacturer's literature.

4.9 Other Equipment. Materials for atmospheric reboilers, surge tanks, lugs, clips, baffles, firetubes, stacks, etc., require identification to a specification which will confirm that the physical and chemical properties are satisfactory for welding with a qualified welding procedure specification.

4.10 Coatings. The purchaser is to specify both internal and external coatings when required. All coatings are to be specified and identified by the coating manufacturer's standard which defines the service restrictions of the material as described in the manufacturer's literature.

4.11 Relief Valves. Relief valves shall comply with the requirement of the ASME Boiler and Pressure Vessel Code Section VIII, Division 1. Specification and identification shall comply with the Manufacturer's standard which defines the pressure-temperature rating and the service requirements as either marked on the part or described in the Manufacturer's literature.

4.12 Rupture Disks. Rupture disks shall comply with the requirements of the ASME Boiler and Pressure Vessel Code Section VIII, Division 1. Specification and identification shall comply with the Manufacturer's standard which defines the pressure-temperature rating and the service requirements as either marked on the part or described in the Manufacturer's literature.

4.13 Instruments. Specification and identification of instruments shall comply with the Manufacturer's standard which defines the pressure-temperature rating either marked on the instrument or described in the Manufacturer's literature.

4.14 Instrument Tubing and Fittings. Tubing and fittings are to be steel. Specification and identification of tubing and fittings shall comply with an ASTM specification. The pressure-temperature rating of the tubing is to be determined by ANSI B31.3.

4.15 Electrical. Electrical components shall be specified to meet the requirements as to class, division, and group using API RP 500B "Recommended Practice for Classification of Locations for Electrical Installations at Drilling Rigs and Production Facilities on Land and on Marine Fixed and Mobile Platforms."

4.16 Welding Materials. Specification of welding materials shall comply with the requirements of the ASME Boiler and Pressure Vessel Code Section IX.

4.17 Insulation. Specification and identification of insulation materials shall comply with an ASTM standard and the Manufacturer's standard which defines the thermal resistivity and temperature rating either marked on the material or described in the Manufacturer's literature. Insulation jacketing shall be alumi-

num or stainless steel. Specification and identification of jacketing shall comply with an ASTM standard and the Manufacturer's standard which defines the thickness and service limits of the material as described in the Manufacturer's literature.

4.18 Trays. Tray support rings, trays, and tray components are to be steel. Specification and identification of tray parts welded to the shell of a pressure vessel shall be specified and identified as required in Paragraph 4.2 of this section. Tray material subject only to minor pressure and load stresses is to comply the specification of an ASTM designation and identification of

the material is to be to the tray manufacturers standard practice of marking or packaging.

4.19 Packing. Specification and identification of packing shall comply with the Manufacturer's standard which defines the type, size, and temperature rating as described in the Manufacturer's literature.

4.20 Mist Extractors. Specification and identification of mist extractors shall comply with the Manufacturer's standard which defines the type, size, and temperature rating as described in the Manufacturer's literature.

SECTION 5 DESIGN

5.1 General. A conventional lease glycol type dehydration unit furnished to this specification is to be a skid mounted assembly. The inlet scrubber and contactor may be skid or foundation mounted separate from the reconcentrator skid upon agreement between the purchaser and the manufacturer.

The User Design Information Sheet and the Manufacturer Data Sheet given in Appendix C may be used by both the purchaser and the manufacturer to specify the detailed requirements of design and fabrication of the equipment.

Sizing criteria for the individual pieces of equipment are given in Appendix D.

5.2 Inlet Scrubber. The inlet scrubber furnished to this specification is to be vertical and is normally available in sizes and maximum allowable working pressure ratings shown in Table 5.1. Table 5.1 is for nominal industry standards. Available sizes and working pressures may vary from the stated ratings. Other types, sizes, pressures, and temperature ratings may be furnished by agreement between the purchaser and manufacturer provided they conform to API Specification 12J.

The inlet scrubber may be separate or integral with the contactor as specified by the purchaser. The inlet scrubber requires a mist extractor and an integral scrubber also requires a chimney tray with a sufficient volume to prevent glycol overflow into the scrubber during shutdown.

5.3 Contactor. The gas contactor furnished to this specification is to be vertical and is normally available in sizes and maximum allowable working pressure ratings shown in Table 5.2. Table 5.2 is for nominal industry standards. Available sizes and working pressures may vary from the stated ratings. Other sizes, pressures, and temperature ratings may be furnished by agreement between the purchaser and manufacturer.

Many types of packing may be used in the contactor for the contacting of the gas with the glycol. Several of the elements are rings, saddles, and structured. A contactor provided with packing shall not exceed 8 feet of packing height without redistribution of the glycol in the tower.

A contactor provided with trays shall utilize a minimum of 18 inches tray spacing.

The contactor shall be provided with a mist extractor to prevent excessive glycol loss. The minimum distance from the top tray to the mist extractor shall be equal to the tray spacing plus six (6) inches. Prevention of gas channeling from the mist extractor to the outlet nozzle shall be accomplished by either a minimum distance of 0.35 times the inside vessel diameter or the addition of an effective outlet distribution system.

5.4 Gas/Glycol Heat Exchanger. The gas-glycol heat exchanger may be either external or internal to the contactor.

5.5 Gas-Condensate-Glycol Separator (optional). A flash separator furnished to this specification may be either two phase or three phase. The separator is sized for the retention time recommended in Appendix D based on the liquid design circulation rate.

5.6 Reboiler. A reboiler furnished to this specification is to be horizontal. The firetube shall be field removable for inspection. The heat duty requirement of the reboiler shall include the benefit of a heat exchanger used for heat recovery in the reconcentrator system.

The reboiler should be designed for a minimum of 1½ psi of internal pressure or full of water, whichever is greater. The deflection of flat end closures should be limited to the diameter divided by 500 with 1½ psi internal pressure or full of water, whichever is greater.

Typical reboiler nominal duties are given in Table D.9 of Appendix D.

5.7 Still Column. A still column furnished to this specification is to be integral with the reboiler. The column is to be flanged such that it is removable and is to be provided with one or more lugs for removal.

5.8 Surge Tank. The surge tank is used to provide glycol for operating purposes and is not considered as storage. Additional holding capacity for glycol from the other equipment during shutdown must be specified by the purchaser.

A surge tank furnished to this specification is to be horizontal and may be integral with the reboiler.

5.9 Glycol-Glycol Heat Exchanger. A glycol to glycol heat exchanger furnished to this specification is to be either external or integral with the surge tank. The exchanger shall be capable of cooling the lean glycol to the maximum temperature recommended by the pump manufacturer.

5.10 Skid. Some skid mounted items may be shipped separately from the skid by agreement of the purchaser and manufacturer. The skid provided to this specification is to have a pull bar or lift lugs for loading and unloading for shipment. The skid is to be capable of a single end lift as assembled for shipment.

5.11 Firetube Heat Flux. The average heat flux shall be no higher than 10,000 BTU/hr.-sq. ft. of exposed area.

Example: 8½" O.D. Sch. 20, 0.25" wall fire tube having 25.0 square feet of surface, 51.85 sq. in. cross sectional area and rated at 250,000 BTU/hr. heat duty.

