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# EQUIPMENT DESCRIPTION

For

# ACID GAS REMOVAL UNIT

AL Project M13-001

Revision 2
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Marketed Exclusively by Total Energy Corp.

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# AGRU PACKAGE

**Project Scope:**

The Acid Gas Removal Unit equipment provided by Air Liquide consists of skid mounted packages and stand alone vessels to condition 170 MMSCFD of natural gas using TSA adsorbents regenerated by a hot oil system and then to reduce the $CO_2$ content using membrane separation and finally to trim the $H_2S$ content using an adsorbent bed to meet pipeline gas specifications. Each of these packages is intended to be mounted in the field with interconnecting piping provided by others. All controls are wired to junction boxes on the skids and will need to be connected by others to the remote Unit Control Panel provided. The equipment has been designed and fabricated according to ASME pressure vessel and piping codes, YPergas Phase 300 project specifications and Total GS 2011 specifications. Most of this equipment is currently located in Batam, Indonesia. The Hot Oil heater and snuffing system are located in the US.

**Equipment Summary:**

The following describes recently fabricated unused equipment designed to remove water vapor, hydrocarbon heavies, $CO_2$ and $H_2S$ from 170 MMSCFD of a bulk dewatered natural gas feed stream (see figure 1 below). It consists of four main processes: 1. Pre-Treatment System; 2. Hot Oil System; 3. Membrane Separation System; and 4. $H_2S$ Removal System. See figure 1 below.

**Pre-Treatment System:**

This equipment is designed for operation at 90.3 barg with an inlet temperature of 45°C. The $CO_2$, water and $H_2S$ concentration make this a sour gas at the inlet of the system. 600# class duplex piping is used in this section of the process. Additional vapor particle dewatering is done in a SS clad inlet separator which will drain to the main plant's process condensate stabilization system. The feed gas is then passed through one bed of the Temperature Swing Adsorption (TSA) system (BASF Sorbead™ technology) to complete dewatering and remove heavy hydrocarbons. Three TSA vessels are used in this process and they alternate between Adsorption, and the regeneration modes of Heating and Cooling in a continuous operation. 900# class piping is used in this section of the process due to the elevated temperatures. Carbon steel piping is used where the gas stream is dry and duplex piping is used where there is a possibility of exposure to condensing sour gas.

Two heat exchangers are used in the regeneration cycle during the heating and cooling of the spent adsorbent. 25 MMSCFD are borrowed from the feed stream to regenerate the offline beds before this gas is returned to the feed stream at the inlet of the TSA vessels. The automatic switching valves and a redundant PLC system manage this process and are programmed to maintain process flow during transitions from mode to mode. The cooled bed is put in adsorption mode before the spent bed is switched to heating mode. The heated bed is then put in cooling mode.

**Hot Oil System:**

The regeneration heat exchanger is powered by the Sigma Thermal hot oil system to do the bulk of the heating job which is to take the regeneration gas up to 290°C. The regeneration economizer is used to recover heat from the bed being cooled and to preheat the gas feeding the regeneration heater. The contaminant laden regeneration gas leaves the economizer and is further cooled in a fin fan air cooler before entering the regeneration separator. Condensate from this separator is sent to the main plant's process condensate stabilization system. Gas exiting the regeneration separator is returned to the feed stream at the inlet to the TSA vessels. The hot oil system uses Eastman Chemical Therminol 66™ heat transfer fluid to take heat from a direct fired gas heater to supply both the regeneration heat exchanger and the membrane pre-heater exchanger. Oil is continuously circulated through this heater and a slip stream is used as needed to maintain temperatures in the heat exchangers.

**Membrane $CO_2$ Separation System:**

Treated feed gas flows from the TSA bed in adsorption mode through the membrane particle filter using Porous Media elements, the membrane pre-heater and then on to the 4 membrane skids in a parallel piping arrangement. This heater is sized to take the gas from 35°C up to 70°C as needed to optimize the separation. **Highly selective proprietary Air Liquide hollow fiber gas separation membranes reduce the $CO_2$ content and $H_2S$ content in the product gas.** The $CO_2$ rich permeate stream is routed to the main plant flare system. The methane rich residue stream is sent to the sales gas piping.

**$H_2S$ Removal System:**

A slip stream from the product gas is passed through an $H_2S$ removal bed (Johnson Matthey Puraspec™ media), a particle filter and then blended with the sales gas to maintain the $H_2S$ content below 12 PPM.

**Location Details:**

The attached "Table of Shipments" lists the equipment provided along with its current location and some physical parameters. Preferred delivery terms are Ex-Works current locations. Further details are available on the following pages and also by request.

Questions regarding the AGRU equipment should be directed to Bob Boyle or the Air Liquide MEDAL Systems Group:

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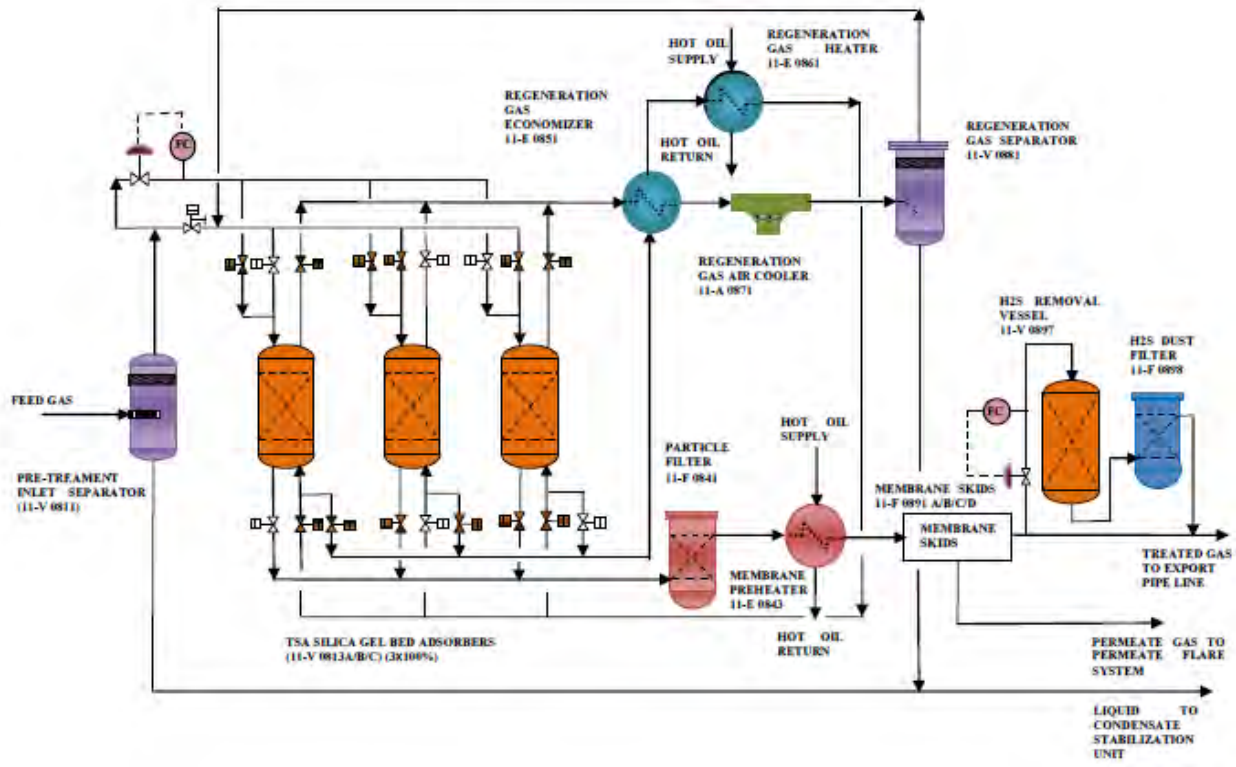



Figure 1.: AGRU Process

## SYSTEM RATINGS TABLE 1

| | | |
|---|---|---|
| Feed flow rate | 170 MMSCFD | Natural Gas @ 82 bar |
| Design Pressure | 90.3 barg/Full Vacuum | |
| Design Temperature | Varies According to Operating Temps | -29 min/65-345 barg max |
| Methane Recovery | 94% | |
| CO2 Reduction | 68% | 22% down to 8% |
| H2S Reduction | 58% | 28 PPM to less than 12 PPM |
| Dew Point Reduction | 41°C | From 31°C to -10°C |
| Water Reduction | 66.4 lb/MMSCF | |
| Other Performance Possible | Contact ALAS to have performance modeled | |

## PRE-TREATMENT PACKAGE (11-PK 0810)

Feed gas is routed to a Pre-Treatment Package with the design flow rate of 170 MMSCFD where the feed gas is dehydrated using TSA Silica Gel Bed Adsorbers (11-V 0813 A/B/C). Silica Gel selectively removes water and hydrocarbons from the feed gas. A small portion of the untreated feed gas is used as Regeneration gas. The Silica Gel Bed when saturated with water and heavy hydrocarbon is regenerated by directing hot regeneration gas through it. The dry gas from bottom of the TSA Silica gel Bed Adsorber (11-V 0813 A/B/C) enters the Particle Filter (11-F 0841) where any traces of solid particles are removed. The filtered Product gas is then sent to Membrane Pre-Heater (11E 0843) for temperature adjustment before routing it to the Membrane $CO_2$ Separation Package (11-PK 0890).

Gas Pre-Treatment Package is comprised of the following equipment:

- Pre-Treatment Inlet Separator (11-V 0811)
- TSA Silica Gel Bed Adsorbers (11-V 0813 A/B/C)
- Particle Filter (11-F 0841)
- Membrane Pre-Heater (11-E 0843)
- Regeneration Gas Economizer (11-E 0851)
- Regeneration Gas Heater (11-E 0861)
- Regeneration Gas Air Cooler (11-A 0871)
- Regeneration Gas Separator (11-V 0881)

## MEMBRANE $CO_2$ SEPARATION PACKAGE AND $H_2S$ REMOVAL PACKAGE (11-PK 0890)

The dry gas from the Pre-Treatment Package may contain contaminants like $CO_2$ and $H_2S$, which when present in certain amounts will cause the gas to be sour. The Membrane Package is designed to remove these components from the Product gas.

Dry feed gas is supplied to the membrane skid at the temperature and pressure specified in the design. This gas passes through the polymeric hollow-fiber membrane elements that are installed in the tubes (up to 4 elements per tube) and is separated into a methane rich export gas stream at near the inlet pressure and a $CO_2$ rich permeate stream at low pressure. This separation happens via the solution-diffusion process. The molecules of gas at high pressure (feed) first solubilise into the active separating layer of the polymeric hollow-fibers which is on the outside of the hollow-fiber. In the solubilised state, the gas molecules diffuse radially across the hollow-fibers from the outside to the inside of the fibers. Some gases like $CO_2$ and $H_2S$ pass across the fiber wall faster than slower gases like $CH_4$. This difference in the solution-diffusion speed is what effectively separates a mixture of gases like $CO_2$ & $CH_4$.

Fast gases like $CO_2$ and $H_2S$ pass through the wall of the membrane fibers and are collected in the permeate stream while slow gases like $CH_4$ go around the membrane fibers and are collected in the export gas stream.

Contaminants like benzene, toluene and xylene block the diffusion path of the fast gases (like $CO_2$) and consequently reduce the permeability of the fibers. In some cases contaminants could also reduce the selectivity of the membrane fibers.

Membrane Package consists of:

- Membrane Skids (11-F 0891 A/B/C/D) for $CO_2$ Removal
- $H_2S$ Removal Vessel (11-V 0897)
- $H_2S$ Dust Filter (11-V 0898)

## HOT OIL SYSTEM (11-PK 0823)

The Sigma Thermal Hot Oil system produces the heat needed to regenerate the TSA Adsorption beds as well as the heat needed to control the temperature of the feed gas for membrane $CO_2$ Separation. The Hot Oil Heater is a gas fired heater. The fuel gas is blended with combustion air in the heater to heat the Therminol 66 heat transfer fluid up to 329°C. This fluid is constantly circulated by the circulation pump through the system with a slip stream passing through a filter to remove any particulates. An installed spare pump is maintained at temperature to minimize the risk of any downtime. The circulation system has an expansion tank to maintain adequate feed supply to these pumps. A Drain Drum is provided to hold the oil during maintenance operations. A snuffing system is included to extinguish the burner in the event of an uncontrolled fire in the heater.

Hot Oil System consists of:

- Hot Oil Heater (11-H 0823)
- Hot Oil Slip Stream Filter (11-F 0825)
- Hot Oil Circulation Pumps (11-P 0827A/B)
- Hot Oil Expansion Tank (11-V 0821)
- Hot Oil Drain Drum (11V 0829)
- Hot Oil Drain Drum Pump (11P 0833)
- Hot Oil Snuffing System

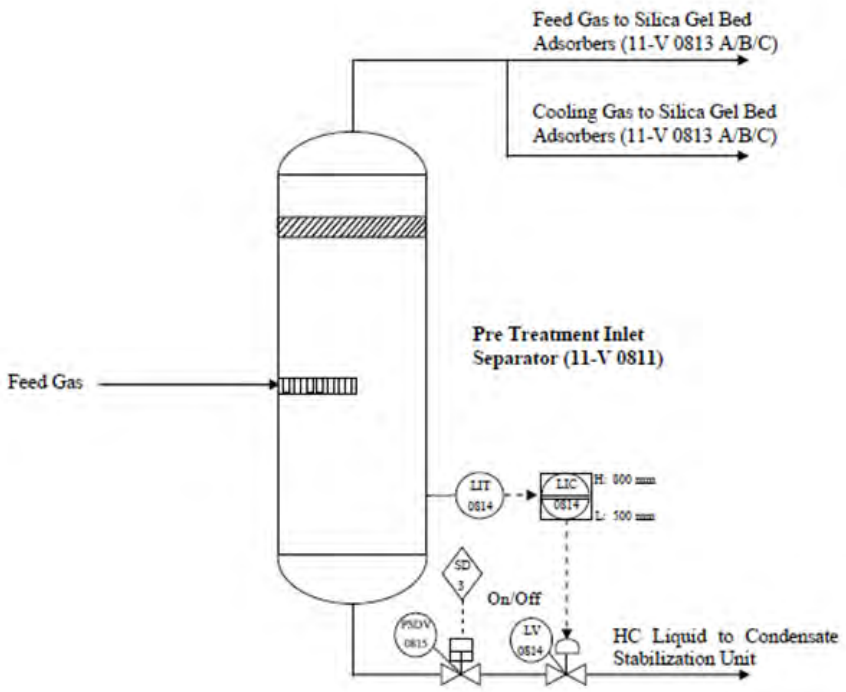
## EQUIPMENT SPECIFICATIONS

| SECTION | EQUIPMENT NAME | TAG NO. | SIZE, mm |
|---|---|---|---|
| Gas treatment package | | | |
| 1. | Pre-treatment Inlet Separator | 11-V 0811 | 1733 (I.D) X 3759 (T/T) |
| 2. | TSA Silica Gel Bed Adsorber (3 X 100%) | 11-V 0813 A/B/C | 2306 (I.D) X 5486 (T/T) |
| 3. | Particle Filter | 11-F 0841 | 1067 (O.D) X 3048 (S/F) |
| 4. | Membrane Pre-Heater | 11-E 0843 | 3987.5 kW (Rated duty) |
| 5. | Regeneration Gas Economizer | 11-E 0851 | 2226 kW |
| 6. | Regeneration Gas Heater | 11-E 0861 | 2345.6 kW (Rated duty) |
| 7. | Regeneration Gas Air Cooler | 11-A 0871 | 3123.6 kW (Rated duty) |
| 8. | Regeneration Gas Separator | 11-V 0881 | 838 (I.D) X 2438 (S/F) |
| 9. | Membrane Package | 11-F 0891 A/B/C/D | Tube : 355.6 (O.D) X 5322.8 (F/F) – 12 PER SKID |
| 10. | $H_2S$ Removal Vessel | 11-V 0897 | 1524 (I.D) X 7214 (T/T) |
| 11. | $H_2S$ Dust Filter | 11-F 0898 | 406 (O.D) X 2100 (T/F) |
| 12. Hot oil system | | | |
| 12.1 | Hot Oil Heater | 11-H 0823 | 6858 kW |
| 12.2 | Hot Oil Slip Stream Filter | 11-F 0825 | VTA |
| 12.3 | Hot Oil Circulation Pumps | 11-P 0827A | 74.6 kW |
| 12.4 | Hot Oil System Expansion Drum | 11-V 0821 | 1524 (I.D) X 4000 (T/T) |
| 12.5a | Hot Oil Drain Drum | 11-V 0829 | 2200 (I.D) X 5000 (T/T) |
| 12.5b | Hot Oil Drain Drum Pump | 11-P 0833 | 12.5 kW |
| 12.6 | Snuffing System | | |

Table 2: Equipment Specifications

## 1. PRE-TREATMENT INLET SEPARATOR (11-V 0811)

| | | |
|---|---|---|
| **Reference P&ID** | : | **YPP-12-11-001-C-MDL** |
| **Equipment Name** | : | **Pre-Treatment Inlet Separator** |
| **Tag Number** | : | **11-V 0811** |
| **Operating Pressure** | : | **82.1 barg** |
| **Operating Temperature** | : | **45°C** |
| **Design Pressure** | : | **90.3 barg/FV** |
| **Design Temperature** | : | **-29/65°C** |
| **Equipment Size** | : | **1733 ID x 3759 T/T mm (1727 mm ID – cladding)** |
| **Material of Construction** | : | **CS + SS316L 3mm Cladding (NACE)** |




Pre-Treatment Inlet Separator (11-V 0811)

Wet Gas with the flow rate of 170 MMscfd is fed to a Pre-Treatment Inlet Separator (11-V 0811). Pre-Treatment Inlet Separator is essential for the proper operation of Gas Pre-Treatment System. Separator is designed to operate at a pressure of 82.1 barg and temperature of 45 °C. It is a two phase separator where the bulk of the liquid will be separated from the feed gas.

Pre-Treatment Inlet Separator consists of a mist eliminator at the top to remove 99% of liquid hydrocarbons and water droplets of 5 microns and above. Liquids that are removed are routed to the main plant condensate stabilization unit by level control.

25.5 MMSCFD of feed gas is split from the gas outlet of Pre-Treatment Inlet Separator. This split gas is used as Regeneration Gas. The Regeneration gas is returned to the feed gas downstream of globe valve before the feed gas passes through the TSA Silica Gel Bed Adsorbers (11-V 0813 A/B/C). A sample tap for the gas composition analyzer is provided at the Feed gas outlet of Pre-Treatment Inlet Separator to monitor the composition of this stream.

## 2. TSA SILICA GEL BED ADSORBERS (11-V 0813 A/B/C)

| | | |
|---|---|---|
| **Reference P&ID** | **:** | **YPP-12-11-003-C-MDL** |
| **Equipment Name** | **:** | **TSA Silica Gel Bed Adsorbers** |
| **Tag Number** | **:** | **11-V 0813 A/B/C** |
| **Operating Pressure** | **:** | **79.32/80.68 barg** |
| **Operating Temperature** | **:** | **44/290°C** |
| **Design Pressure** | **:** | **90.3 barg/FV** |
| **Design Temperature** | **:** | **-29/310°C** |
| **Equipment Size** | **:** | **2306 ID x 5486 T/T mm** |
| **Material of Construction** | **:** | **CS + 3 mm SS316L Cladding+3 mm CA (NACE)** |

TSA Silica Gel Bed Adsorber unit comprises three towers which operate as follows:

-One Tower in adsorption mode

-One Tower in hot regeneration cycle and

-One Tower in cold regeneration cycle

Feed gas from the Pre-Treatment Inlet separator (11-V 0811) enters into the TSA Silica Gel Bed Adsorber on adsorption mode (3x100%) in down flow direction for Dehydration. After leaving the adsorption tower the dry gas enters into the Particle Filter (11-F 0841).

The regeneration gas with a maximum flowrate of 25.5 MMscfd of untreated feed gas is then taken downstream of the Pre-Treatment Inlet Separator (11-V 0811) and goes first to the Silica Gel Bed on cold regeneration cycle in a down flow direction. Here a significant proportion of the overall regeneration heat is recovered. After leaving the tower the gas enters into the Regeneration Gas Economizer (11-E 0851) to recover heat from the gas exiting the tower on hot regeneration cycle, and then on to the Regeneration Gas Heater (11-E 0861) where it is heated to the desired regeneration temperature.

The hot regeneration gas from the Regeneration Gas Heater (11-E 0861) is passed in a counter-flow (up flow) direction through the Silica Gel Bed on hot regeneration cycle. After leaving the bed the regeneration gas enters into the tube side of the Regeneration Gas Economizer (11-E 0851).

The beds consist of the following layers:

The bed contains a combination of two types of Sorbead. The main part of the bed comprises Sorbead H – the hydrocarbon adsorption grade. There is a layer of Sorbead WS on top of the Sorbead H as a protection against any water or hydrocarbon mists or droplets. Some may be formed downstream of the Regeneration Forcing Valve (11-HV 0821), and also after the saturated regeneration gas is remixed with the feed gas.

Adsorption and Regeneration of beds are achieved by the sequential operation of switching valves located at the inlet and outlet of Adsorbers. Each bed sequentially moves through a cycle which includes an adsorption phase, a hot regeneration phase and then a cold regeneration phase.

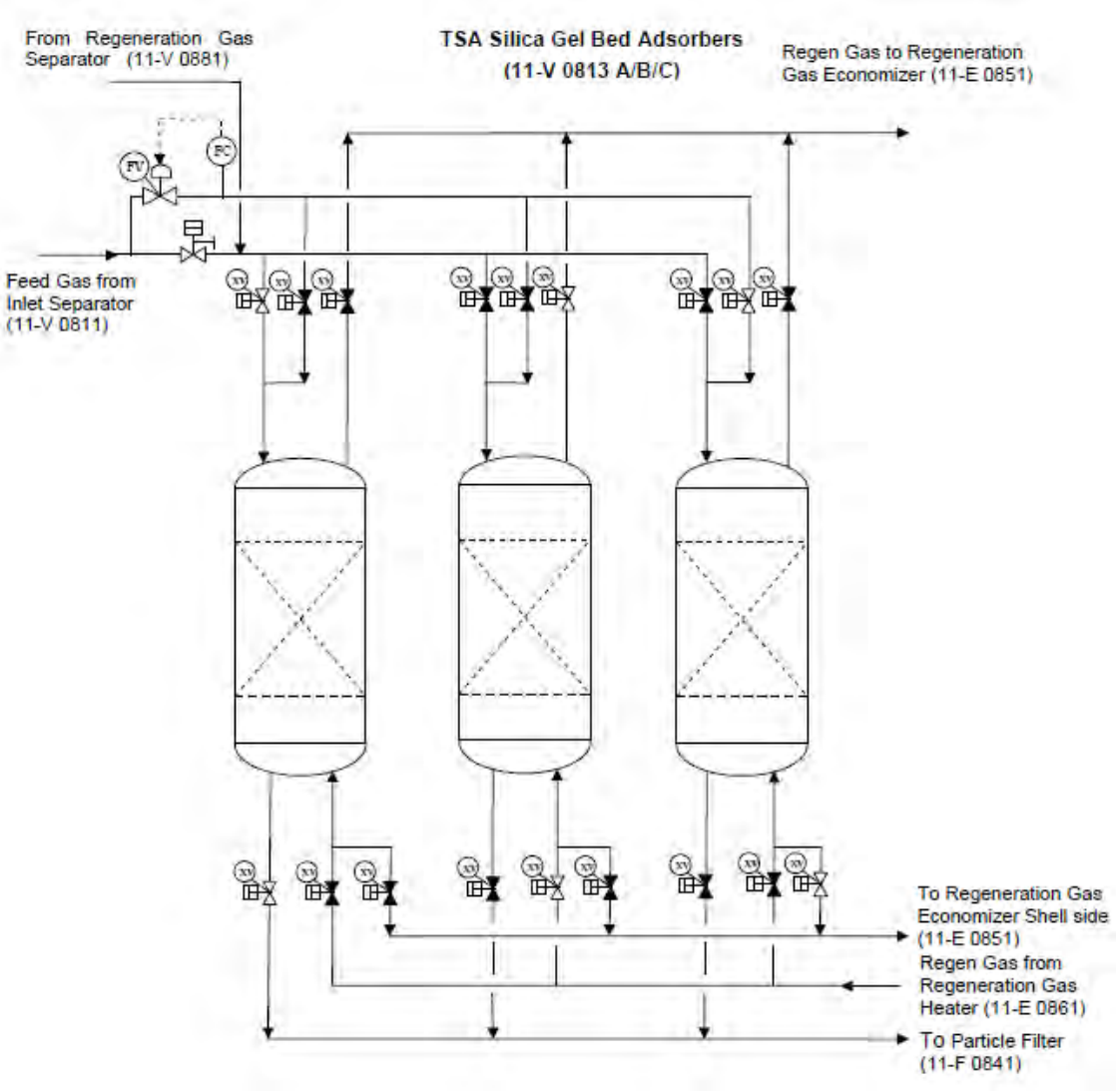
Adsorption and Regeneration of the beds are automatically executed from the remote mounted PLC control panel on Pre-programmed cycles.

The bed is designed to last for a time of approximately 3-4 years after which the bed materials will need to be replaced.

**The following are the operation cycles:**

| No. | Cycles | Cycle period (mins) | Operating Pressure (barg) | Operating Temperature (°C) |
|---|---|---|---|---|
| 1 | Adsorption cycle (1 Adsorber) | 45 | 79.32 | 44 |
| 2 | Regeneration cycle - Hot mode | 45 | 80.68 | 290 |
| 3 | Regeneration cycle – Cold mode | 45 | 81.32 | 44.7 |

TSA Operation Cycles

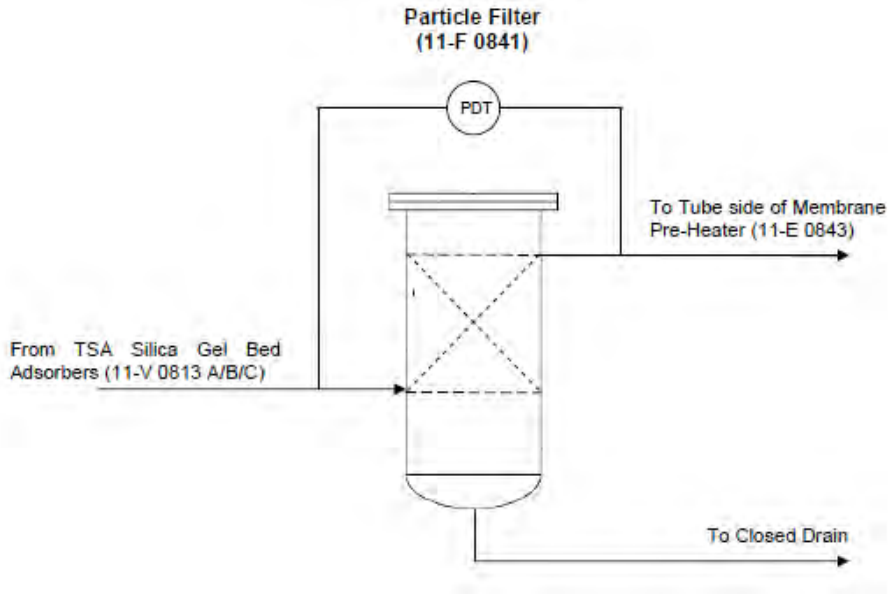



TSA Silica Gel Bed Adsorbers (11-V 0813 A/B/C)

## 3. PARTICLE FILTER (11-F 0841)

| | | |
|---|---|---|
| **Reference P&ID** | : | **YPP-12-11-004-C-MDL** |
| **Equipment Name** | : | **Particle Filter** |
| **Tag Number** | : | **11-F 0841** |
| **Operating Pressure** | : | **78.06 barg** |
| **Operating Temperature** | : | **44°C** |
| **Design Pressure** | : | **90.3 barg/FV** |
| **Design Temperature** | : | **-29/65°C** |
| **Equipment Size** | : | **1067 OD x 2314 T/F mm** |
| **Material of Construction** | : | **CS + 3 mm CA** |

The dry gas from bottom of the TSA Silica Gel Bed Adsorber is sent to the Particle Filter (11-F 0841) (1 x 100%) to remove the traces of particulate dust (Sorbead H and Sorbead WS). Filter element shall be rated 99.9% removal at 0.3 micron and above. The filtered product gas is then sent to Membrane Skids (11-F 0891A/B/C/D) via Membrane Pre-heater (11-E 0843). On line sample connection is provided at the filter outlet.

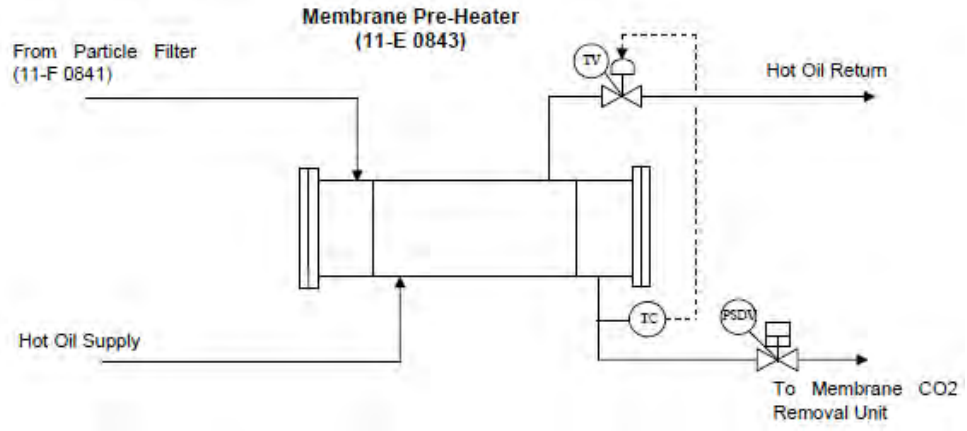



Particle Filter (11-F 0841)

## 4. MEMBRANE PRE-HEATER (11-E 0843)

| | | |
|---|---|---|
| **Reference P&ID** | : | **YPP-12-11-005-C-MDL** |
| **Equipment Name** | : | **Membrane Pre-Heater** |
| **Tag Number** | : | **11-E 0843** |
| **Operating Pressure (Shell In/Out)** | : | **2.85/2.35 barg** |
| **Operating Pressure (Tube In/Out)** | : | **77.68/77.34 barg** |
| **Operating Temperature (Shell In/Out):** | | **329/297.5°C** |
| **Operating Temperature (Tube In/Out):** | | **43.9/(50-70)°C** |
| **Design Pressure (Shell)** | : | **8.4 barg/FV** |
| **Design Pressure (Tube)** | : | **90.3 barg** |
| **Design Temperature (Shell/Tube)** | : | **-29/345°C** |
| **Material of Construction** | : | **Shell: CS+3 mm CA, Tube: CS** |

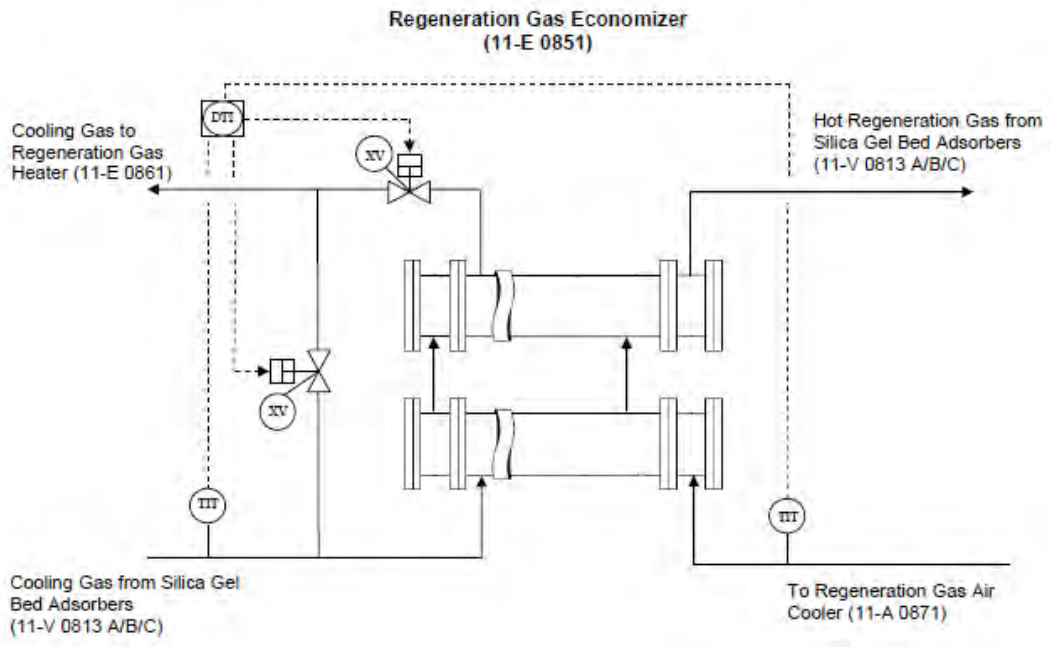
Membrane Pre-heater (11-E 0843) is located upstream of membrane skids (11-F 0891A/B/C/D) to heat the dry gas to the required levels to achieve optimal removal efficiency. The Membrane Pre-heater is a shell and tube exchanger. Filtered gas at max of 45 °C from Particle filter (11-F 0841) is routed to the tube side of the exchanger to achieve a nominal temperature of 50 °C to 70 °C (max duty case) using Hot Oil as heating medium in the shell side of the Exchanger. Membrane Pre-heater utilizes the Hot Oil (329 °C) to heat the gas which is sent to the Membrane Skids (11-F 0891 A/B/C/D) for $CO_2$ removal. Process gas outlet temperature is controlled by a temperature control valve located at the outlet of hot oil supply. Water dew point analyzer and Hydrocarbon dew point analyzer are provided by the customer at the gas outlet of Membrane Pre-heater.




Membrane Pre-Heater (11-E 0843)

## 5. REGENERATION GAS ECONOMIZER (11-E 0851)

| | | |
|---|---|---|
| **Reference P&ID** | : | **YPP-12-11-004-C-MDL** |
| **Equipment Name** | : | **Regeneration Gas Economizer** |
| **Tag Number** | : | **11-E 0851** |
| **Operating Pressure (Shell In/Out)** | : | **81.36/81.02 barg** |
| **Operating Pressure (Tube In/Out)** | : | **80.31/79.97 barg** |
| **Operating Temperature (Shell In/Out)** | : | **(45-290)/208.6℃** |
| **Operating Temperature (Tube In/Out)** | : | **(45-290)/144.7℃** |
| **Design Pressure (Shell/ Tube)** | : | **90.3 barg/FV** |
| **Design Temperature (Shell/Tube)** | : | **-29/310°C** |
| **Material of Construction** | : | **Shell: CS+3 mm CA, Tube: SS316 (NACE),** |
| | | **Tube side: CS+3mm CA** |




Regeneration Gas Economizer (11-E 0851)

Regeneration Gas Economizer consists of a pair of Shell and Tube type Heat Exchangers in series. The cold stream from bottom of the TSA Silica Gel Bed Adsorbers (11-V 0813 A/B/C) is routed to the shell side of the Regeneration Gas Economizer (11-E 0851) where the gas is preheated (from max 75 °C to 208 °C) by a hot Regeneration gas (at 290 °C) exiting the top of the TSA Silica Gel Bed Adsorber. Heat is recovered from the Regeneration gas to reduce the duty of Regeneration Gas Heater (11-E 0861).

The preheated gas is directed to Regeneration Gas Heater (11-E 0861) and the tube side outlet is sent to the Regeneration Gas Cooler (11-A 0871).

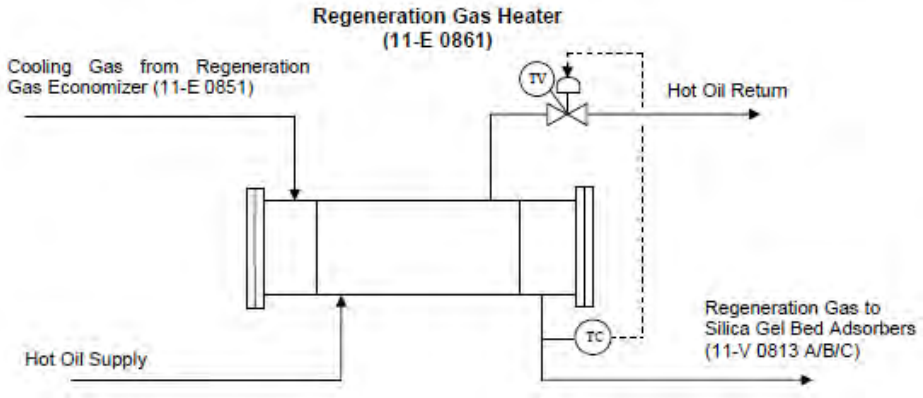
Initially the Economizer is bypassed until the hot Regeneration gas from the TSA Silica Gel bed is hotter than the cooling gas from the TSA Silica Gel bed at which point the bypass closes and heat exchange starts. This happens at around 167.5 °C at the midpoint of the Regeneration cycle.

## 6. REGENERATION GAS HEATER (11-E 0861)

| | | |
|---|---|---|
| **Reference P&ID** | : | **YPP-12-11-005-C-MDL** |
| **Equipment Name** | : | **Regeneration Gas Heater** |
| **Tag Number** | : | **11-E 0861** |
| **Operating Pressure (Shell In/Out)** | : | **2.85/2.35 barg** |
| **Operating Pressure (Tube In/Out)** | : | **81.02/80.68 barg** |
| **Operating Temperature (Shell In/Out):** | | **329/297.5°C** |
| **Operating Temperature (Tube In/Out):** | | **178.8/290°C** |
| **Design Pressure (Shell)** | : | **8.4 barg/FV** |
| **Design Pressure (Tube)** | : | **90.3 barg** |
| **Design Temperature (Shell/Tube)** | : | **-29/345°C** |
| **Material of Construction** | : | **Shell: CS+3 mm CA (NACE), Tube: CS** |

Regeneration Gas Heater is a Shell and Tube Exchanger. The pre-heated gas from the Regeneration Gas Economizer enters into the tube side of the Regeneration gas Heater where the gas is heated to maximum temperature of 290 °C using Hot Oil as heating medium in the shell side of the Exchanger. The heating medium is circulated synthetic thermal oil from a Fired Hot Oil Heater system.

This hot Regeneration gas enters the bottom of the adsorber in hot regeneration mode and strips the bed of water and heavy hydrocarbons as the gas flows upwards through the tower. The hot regeneration gas exits the top of this bed and is sent through the shell side of the Regeneration gas Economizer where it is used to pre-heat the gas in the tube side (cool gas).
Regeneration gas outlet temperature is controlled by a temperature control valve located at the outlet of Hot Oil Supply.




Regeneration Gas Heater (11-E 0861)

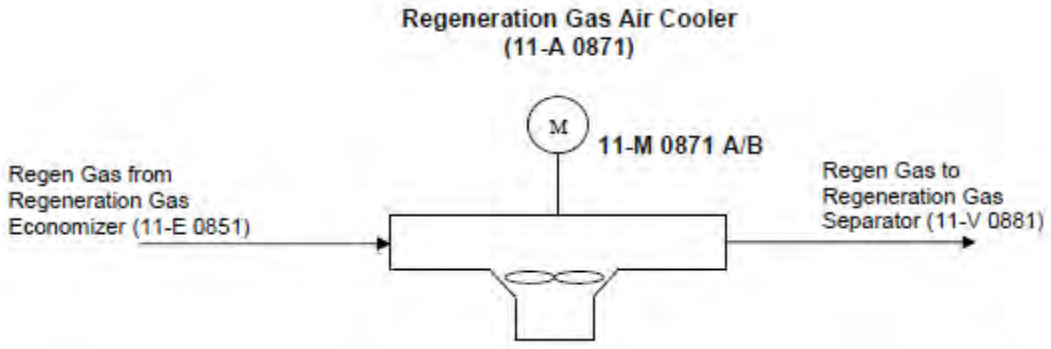
## 7. REGENERATION GAS AIR COOLER (11-A 0871)

| | | |
|---|---|---|
| **Reference P&ID** | : | **YPP-12-11-002-C-MDL** |
| **Equipment Name** | : | **Regeneration Gas Air cooler** |
| **Tag Number** | : | **11-A 0871** |
| **Operating Pressure** | : | **79.97 barg** |
| **Operating Temperature** | : | **177.3/45°C** |
| **Design Pressure** | : | **90.3 barg/FV** |
| **Design Temperature** | : | **-29/310°C** |
| **Material of Construction** | : | **Tubes & Header: DSS; Housing: CS (NACE)** |

The gas downstream of the tube side of the Regeneration Gas Economizer (11-E 0851) is routed to the Regeneration Gas Air Cooler (11-A 0871) where the gas is cooled to 45 °C. Regeneration Gas Air Cooler is a Forced Draft Air Cooler which uses ambient air to cool the Regeneration Gas from 177.3 °C to 45 °C.

The air is forced through the tubes by means of fans. The outlet temperature of regeneration Gas Air Cooler is maintained constant by starting/stopping the fans in operation and by use of the fan motor pole switching. The motor configuration is 2 x 50%. The number of fans in operation will basically depend upon the amount of heat to be removed and the air outlet temperature.

The cool regeneration gas is then sent to the Regeneration Gas Separator (11-V 0881).

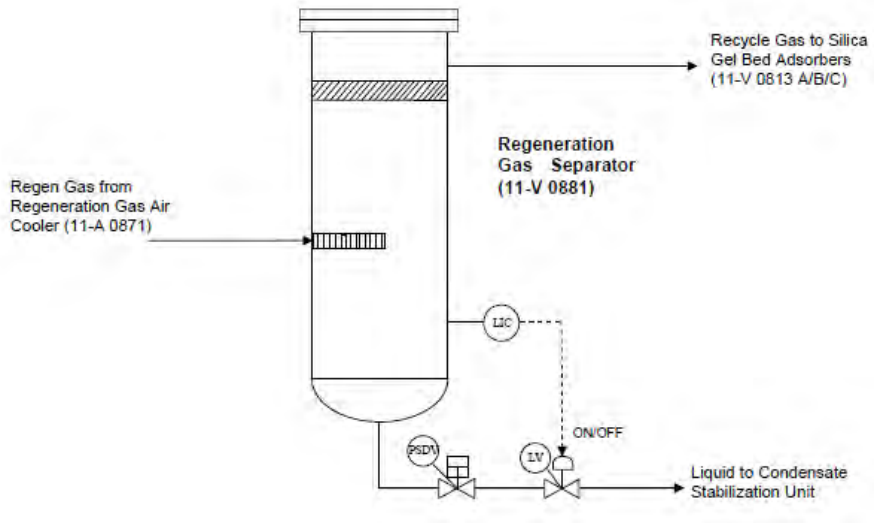



Regeneration Gas Air Cooler (11-A 0871)

## 8. REGENERATION GAS SEPARATOR (11-V 0881)

| | | |
|---|---|---|
| **Reference P&ID** | : | **YPP-12-11-002-C-MDL** |
| **Equipment Name** | : | **Regeneration Gas Separator** |
| **Tag Number** | : | **11-V 0881** |
| **Operating Pressure** | : | **79.55 barg** |
| **Operating Temperature** | : | **45°C** |
| **Design Pressure** | : | **90.3 barg/FV** |
| **Design Temperature** | : | **-29/145°C** |
| **Equipment Size** | : | **844 ID x 2438 T/F mm** |
| **Material of Construction** | : | **CS + 316LSS 3mm Cladding (NACE)** |

The gas from Regeneration gas Air Cooler (11-A 0871) is routed to Regeneration Gas Separator (11-V 0881). Separator is designed to operate at pressure of 79.55 barg and temperature of 45°C.




Regeneration Gas Separator (11-V 0881)

Regeneration Gas Separator consists of a Mist Eliminator at the top, to remove 99% of liquid hydrocarbons and water droplets of 5 microns and above. Regeneration Gas Separator is a two phase separator where bulk liquids are separated. Separated condensate is routed to the main plant Condensate Stabilization Unit using level control. The dry/saturated gas is finally directed back (recycled) to upstream of TSA Silica Gel Bed Adsorbers.

## 9. MEMBRANE SKIDS (11-F 0891 A/B/C/D)

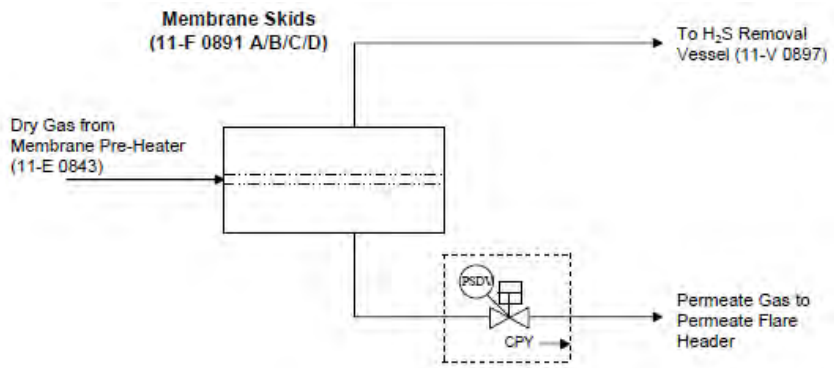
| | | |
|---|---|---|
| **Reference P&ID** | : | **YPP-12-11-006-C-MDL** |
| **Equipment Name** | : | **Membrane Unit** |
| **Tag Number** | : | **11-F 0891 A/B/C/D** |
| **Operating Pressure** | : | **77.34 barg** |
| **Operating Temperature** | : | **50-70°C** |
| **Design Pressure** | : | **90.3 barg** |
| **Design Temperature** | : | **-29/85°C** |
| **Equipment Size** | : | **12 Tubes (Each 355.6 OD x 5322.8 Critical length mm)** |
| **Material of Construction** | : | **CS+3 mm CA** |

Following the Pretreatment presented above, the Process gas from the Membrane Pre- Heater (11-E 0843) enters the Membrane Skids (11-F 0891 A/B/C/D) for Acid gas removal.

The $CO_2$ removal membrane configuration is enabled by four Membrane skids (11-F 0891 A/B/C/D)with each one consisting of 12 permeator tubes.

The $CO_2$ removal membrane system utilizes high selectivity Polyimide based hollow fiber membranes for separation of $CO_2$ from the dry gas. Membrane unit operates at a pressure of 77.3 barg with a maximum temperature of 70°C and is designed to remove $CO_2$ down to pipeline specifications ($CO_2$ < 8.5 mol%) . High $CO_2$ permeate gas is sent to the permeate flare system. Gas composition analyzer is provided by the customer at the permeate gas outlet to the permeate flare header.

**The design flow rate may be increased to 204 MMSCFD with the addition of a future 5th Membrane skid.**

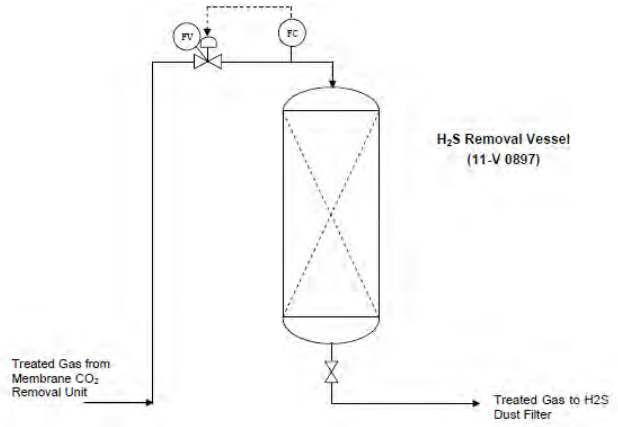



Membrane Skids (11-F 0891 A/B/C/D)

## 10. $H_2S$ REMOVAL VESSEL (11-V 0897)

| | | |
|---|---|---|
| **Reference P&ID** | : | **YPP-12-11-008-C-MDL** |
| **Equipment Name** | : | **$H_2S$ Removal Vessel** |
| **Tag Number** | : | **11-V 0897** |
| **Operating Pressure** | : | **76.46 barg** |
| **Operating Temperature** | : | **40-70°C** |
| **Design Pressure** | : | **90.3 barg/FV** |
| **Design Temperature** | : | **-29/85°C** |
| **Equipment Size** | : | **1524 ID x 7214 T/T mm** |
| **Material of Construction** | : | **CS + 1.27 mm CA** |

A slip stream of 16.3 MMSCFD from the Product gas emerging from the membrane system is directed through a $H_2S$ single bed adsorption system. This system is designed to reduce the $H_2S$ content in the final gas to below 12 ppmv and operate at a pressure of 76.46 barg and temperature of 40-70 °C (Max).




$H_2S$ Removal Vessel (11-V 0897)

The beds consist of the following layers:

- Layer 1 – Layers of Support balls at the top and bottom.
- Layer 2 – 11.33 $m^3$ of PURASPEC 1038™ catalyst sandwiched between the layers.

The Product gas from the outlet of the removal vessel contains 0 ppm of $H_2S$. Then the treated gas is sent to the $H_2S$ Dust Filter (11-F 0898) to remove any dust particles from bed materials.
The bed is designed to last for a time of approximately 12 months after which the PURASPEC™ will need to be replaced.

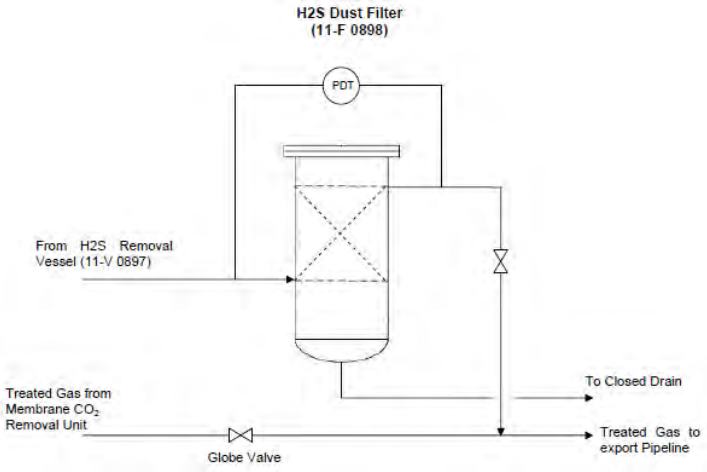
## 11. $H_2S$ DUST FILTER (11-F 0898)

| | | |
|---|---|---|
| **Reference P&ID** | : | **YPP-12-11-008-C-MDL** |
| **Equipment Name** | : | **$H_2S$ Dust Filter** |
| **Tag Number** | : | **11-F 0898** |
| **Operating Pressure** | : | **76.16 barg** |
| **Operating Temperature** | : | **40-70°C** |
| **Design Pressure** | : | **90.3 barg/FV** |
| **Design Temperature** | : | **-29/85°C** |
| **Equipment Size** | : | **406 OD x 2100 T/F mm** |
| **Material of Construction** | : | **CS + 3 mm CA** |

Treated gas from the $H_2S$ Removal Vessel (11-V 0897) is sent to the $H_2S$ Dust Filter (11-F0898) (1 x 100%) to remove the traces of dust (Packing materials) particles. Filter element shall be rated 99.9% removal at 0.3 micron and above.

The gas exiting from the $H_2S$ system will blend with the remaining bypassed product gas to achieve the desired quantity of 12 ppmV. Then the sweetened gas is sent to export via CPF- NPA pipeline.

A water dew point analyzer & a gas composition analyzer are provided by the customerat the product gas outlet to characterize the water dew point and $H_2S$ content of the product gas.




$H_2S$ Dust Filter (11-F 0898)

## 12. HOT OIL SYSTEM

**Reference UFD: YPP-11-11-001-C-MDL**

**The Hot Oil system consists of the following units:**

- **Fired Hot Oil Heater (11-H 0823)**
- **Hot Oil Slip Stream Filter (11-F 0825)**
- **Hot Oil Circulation Pumps (11-P 0827 A/B)**
- **Hot Oil Expansion Drum (11-V 0821)**
- **Hot Oil Drain Drum (11-V 0829)**
- **Hot Oil Drain Drum Pump (11-P 0833)**
- **Snuffing System**

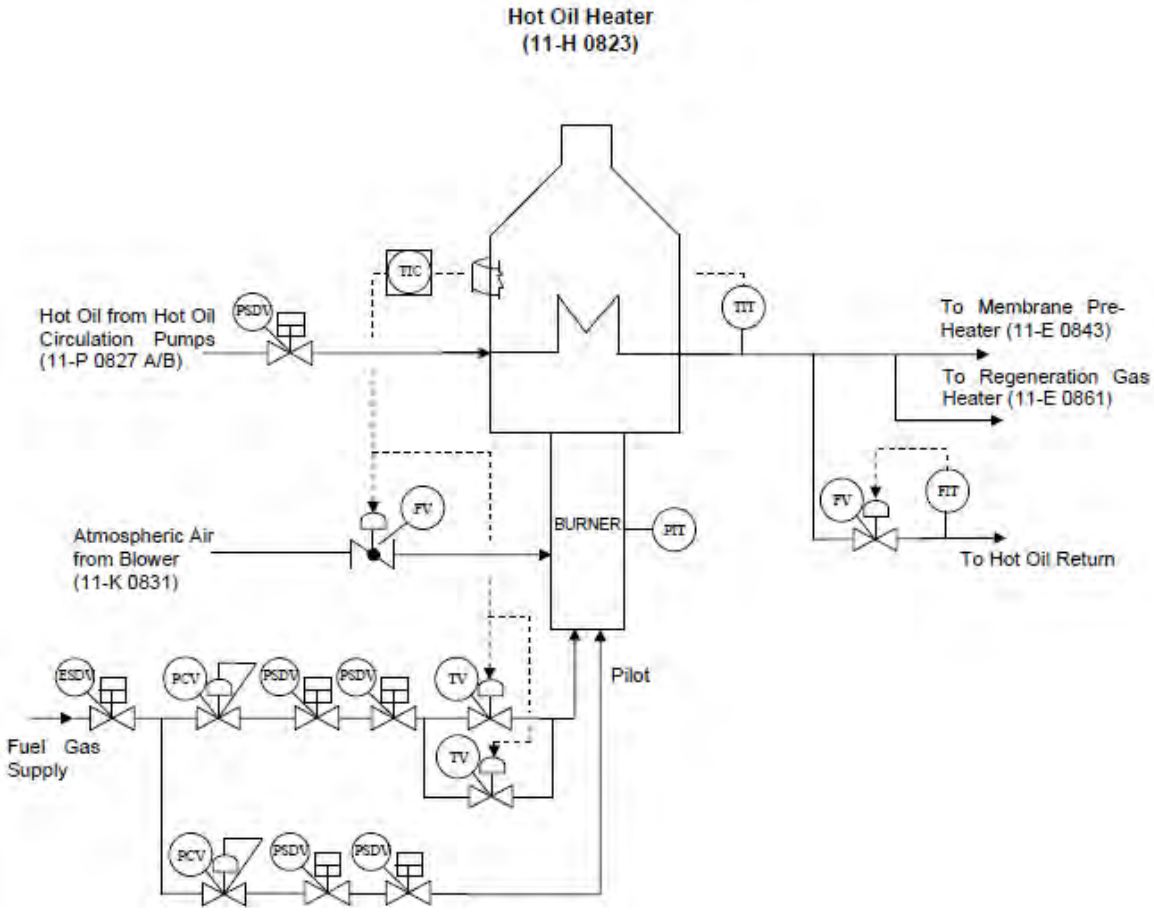
Therminol 66 is used as Hot Oil. The supply pressure of the unit is 2.8 barg. Supply Temperature of Hot Oil is 329 °C and the return temperature range is 294.5°C to 297.5°C. The design requirements for the above equipment are as follows:

### 12.1 HOT OIL HEATER (11-H 0823)

| | | |
|---|---|---|
| **Reference P&ID** | **:** | **YPP-12-11-009-C-MDL (Sht 1 of 6)** |
| **Equipment Name** | **:** | **Hot oil Heater** |
| **Tag Number** | **:** | **11-H 0823** |
| **Operating Pressure** | **:** | **2.8 barg** |
| **Operating Temperature** | **:** | **297.5/329°C** |
| **Design Pressure** | **:** | **17.24 barg** |
| **Design Temperature** | **:** | **345°C** |
| **Material of Construction** | **:** | **Shell: CS+1.27 mm CA; Tube: CS+3 mm CA** |

Hot Oil Heater is a horizontal high efficiency heater utilizing a double helical coil design. The high efficiency double coil design eliminates the need for internal shell insulation. A gas fired burner is provided. The burner package will contain a Combustion Air Blower (11-K 0831) and fuel gas control system that allows good control throughout the burner turndown. The burner is mounted on the Hot Oil Heater.

Hot Oil Heater is designed to operate at a pressure of 2.8 barg and temperature of 329°C. Fuel gas burner is used to heat the Hot Oil from 297.5°C to a temperature of 329°C. Hot Oil is pumped at a constant flow rate (346.4 $m^3$/hr or 1525 gpm) through the heater and distributed directly to the exchangers. Flow control valves are utilized to modulate the flow rate and control to the desired process temperature at each exchanger.




Hot Oil Heater (11-H 0823)

## 12.2 HOT OIL SLIP STREAM FILTER (11-F 0825)

| | | |
|---|---|---|
| **Reference P&ID** | : | **YPP-12-11-009-C-MDL (Sht. 3 of 4)** |
| **Equipment Name** | : | **Hot Oil Slip Stream Filter** |
| **Tag Number** | : | **11-F 0825** |
| **Operating Pressure** | : | **5.7 barg** |
| **Operating Temperature** | : | **294-312°C** |
| **Design Pressure** | : | **8.4 barg** |
| **Design Temperature** | : | **345°C** |
| **Material of Construction** | : | **CS + 3 mm CA** |

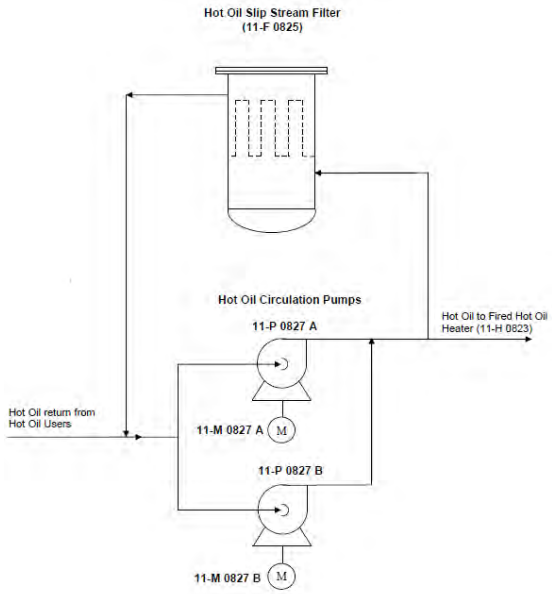
Hot Oil Slip Stream Filter is a Cartridge type glass fiber and used to remove any particles in the Hot Oil. Hot Oil Filter is sized for 10% of Hot Oil Circulation Pump's capacity. The Cartridge Filter is to

collect solids of 5 micron and larger. Hot Oil Filter operates at a pressure of 5.7 barg and temperature 294 °C to 312 °C at any (dirty or clean) condition.

## 12.3 HOT OIL CIRCULATION PUMPS (11-P 0827 A/B)

| | | |
|---|---|---|
| **Reference P&ID** | : | **YPP-12-11-009-C-MDL (Sht. 3 of 6)** |
| **Equipment Name** | : | **Hot Oil Circulation Pumps** |
| **Tag Number** | : | **11-P 0827 A/B** |
| **Operating Pressure (suction/Discharge)** | : | **1/5.7 barg** |
| **Working Temperature** | : | **294/312°C** |
| **Design Pressure** | : | **8.4 barg** |
| **Design Temperature** | : | **345°C** |
| **Material of Construction** | : | **Casing: CS, Impeller: 13% Cr Steel** |

Hot Oil is pumped to a Hot Oil Heater (11-H 0823) using Hot Oil Circulation Pumps (11-P 0827 A/B). Hot Oil Circulation Pumps (2 X 100%) are Centrifugal type operating at a discharge pressure of approximately 5.7 barg. The Hot Oil Circulation Pumps operate at a constant 346 $m^3$/hr (1525 GPM). During turndown, flow is maintained by minimum flow recycle around the users. Hot stand-by provision is made for the stand-by pump to avoid thermal shock when this pump is used. Hot standby is used as a fail over mechanism to provide reliability. Hot standby is active and connected as part of the system, i.e., if the primary pump fails, the hot standby pump is switched into operation. To enable this, a dedicated bypass across the check valve is provided to keep the standby pump warm by circulating a small hot oil flow from the discharge header.

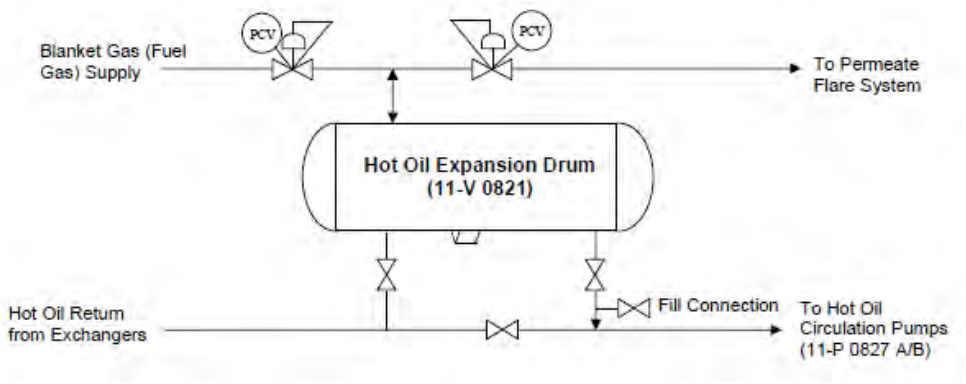



Hot Oil Circulation Pumps (11-P 0827 A/B) and Slip Stream Filter (11-F 0825)

## 12.4 HOT OIL EXPANSION DRUM (11-V 0821)

| | | |
|---|---|---|
| **Reference P&ID** | : | **YPP-12-11-009-C-MDL (Sht. 4 of 4)** |
| **Equipment Name** | : | **Hot Oil Expansion Drum** |
| **Tag Number** | : | **11-V 0821** |
| **Operating Pressure** | : | **0.7 barg** |
| **Operating Temperature** | : | **294/312°C** |
| **Design Pressure** | : | **8.4/FV barg** |
| **Design Temperature** | : | **AMB/345°C** |
| **Equipment Size** | : | **1524 ID x 4000 T/T mm** |
| **Material of Construction** | : | **CS + 3 mm CA** |

Hot Oil Expansion Drum is a horizontal drum which provides storage to accommodate variations in the Hot Oil system caused by the temperature difference. Hot Oil Expansion Drum operates at blanket gas pressure of 0.7 barg and temperature of 294-312 °C. Generally the expansion drum is up to 1/3 full when the system is cold. When the system is running hot, it will be 2/3 to 3/4 full. There are usually two pipes or legs that run to the Expansion Drum and when running, one leg needs to be closed to prevent thermal currents from running into the Expansion Drum and heating up the fluid. Thus Hot oil does not normally flow through the drum to ensure it is not normally operating hot and reduce heat losses. Fuel gas is provided as blanket gas to supplement the gas flow as necessary to maintain the vessel operating pressure and to eliminate oxidation in this tank.



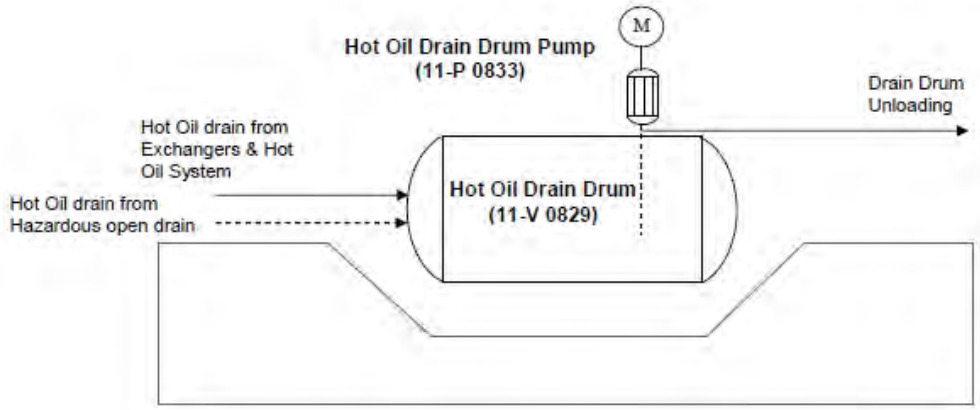

Hot Oil Expansion Drum (11-V 0821)

## 12.5 HOT OIL DRAIN DRUM (11-V 0829) & PUMP (11-P 0833)

| | | |
|---|---|---|
| **Reference P&ID** | : | **YPP-12-11-010-C-MDL** |
| **Equipment Name** | : | **Hot Oil Drain Drum** |
| **Tag Number** | : | **11-V 0829** |
| **Operating Pressure** | : | **ATM** |
| **Operating Temperature** | : | **60/329°C** |
| **Design Pressure** | : | **FOW** |
| **Design Temperature** | : | **20/345°C** |
| **Equipment Size** | : | **2300 ID x 5000 T/T mm** |
| **Material of Construction** | : | **CS + 3 mm CA** |

Hot oil drain drum receives hot oil drained from the Exchangers (Membrane Pre Heater (11-E 0843) and Regeneration Gas Heater (11-E 0861)) and Hot Oil System by gravity flow. Then the hot oil is pumped to the drain drum unloading area by hot oil drain drum pump (11-P 0833). Hot oil is unloaded in drums and transported by trucks.

| | | |
|---|---|---|
| **Reference P&ID** | : | **YPP-12-11-010-C-MDL** |
| **Equipment Name** | : | **Hot Oil Drain Drum Pump** |
| **Tag Number** | : | **11-P 0833** |
| **Operating Pressure (Suction/Discharge)** | : | **ATM/4 barg** |
| **Operating Temperature** | : | **60/329°C** |
| **Design Pressure** | : | **7 barg** |
| **Design Temperature** | : | **20/345°C** |
| **Material of construction** | : | **Casing: CS, Impeller: 13% Cr Steel** |



### 12.6 $CO_2$ SNUFFING SYSTEM

The fitting of an automatic controlled snuffing system on vent stacks is provided in order to avoid continuous burning in the event of accidental ignition of the vented gases.

The snuffing medium is carbon dioxide. The vent snuffing system consists of $CO_2$ cylinder bottles provided in the rack.

Thermal detectors (2oo2 voting) in the exhaust stack of the heater will activate the system and open the XV (11-XV 0834) to release the $CO_2$ from the cylinders. Provision to operate these cylinders from UCP Panel and RTU is also provided. The snuffing facility is sized per NFPA 12 according to the volume of the heater, the operating temperature and the combustible material (natural gas) in the heater.

## 13. RELIEF SYSTEMS

The table here below summarizes the relief devices included in this package.

| TAG NUMBER | LOCATION | SET POINT barg | DESIGN CASE | SIZE Inlet - Orifice - Outlet |
|---|---|---|---|---|
| PSV 0816 | 11-V 0811 | 90.3 | FIRE CASE | 1" D 2" |
| PSV 0817 A/B/C | 11-V 0813 A/B/C | 90.3 | FIRE CASE | 2" H 3" |
| PSV 0822 A/B | 11-H 0823 | 8.4 | THERMAL EXPANSION | 1 ½" F 2" |
| PSV 0823 | 11-F 0825 | 8.4 | FIRE CASE | 1" D 2" |
| PSV 0824 | 11-V 0821 | 8.4 | FIRE CASE | 1 ½" G 3" |
| PSV 0841 | 11-V 0841 | 90.3 | FIRE CASE | 1" D 2" |
| PSV 0845 | 11-F 0898 | 90.3 | FIRE CASE | 1" D 2" |
| PSV 0850 | 11-E 0851 | 90.3 | FIRE CASE | 1" F 2" |
| PSV 0864 | 11-E 0843 | 90.3 | FIRE CASE | 1" D 2" |
| PSV 0865 | 11-E 0861 | 90.3 | FIRE CASE | 1 ½" D 2" |
| PSV 0885 | 11-V 0881 | 90.3 | FIRE CASE | 1" D 2" |
| PSV 0898 | 11-V 0897 | 90.3 | FIRE CASE | 1 ½" G 3" |

Table 3: Relief Systems

**FABRICATION PHOTOS**
**28 FEBRUARY 2015**

## -MEMBRANE SKID-

**11-F-0891 A/B**

**11-F-0891 C/D**

TSA SILICA GEL BED ADSORBER SWITCHING VALVE SKID (11-PK 0813A/B)

**BOTTOM SKID**

**TOP SKID**

## REGENERATION ECONOMIZER SKID

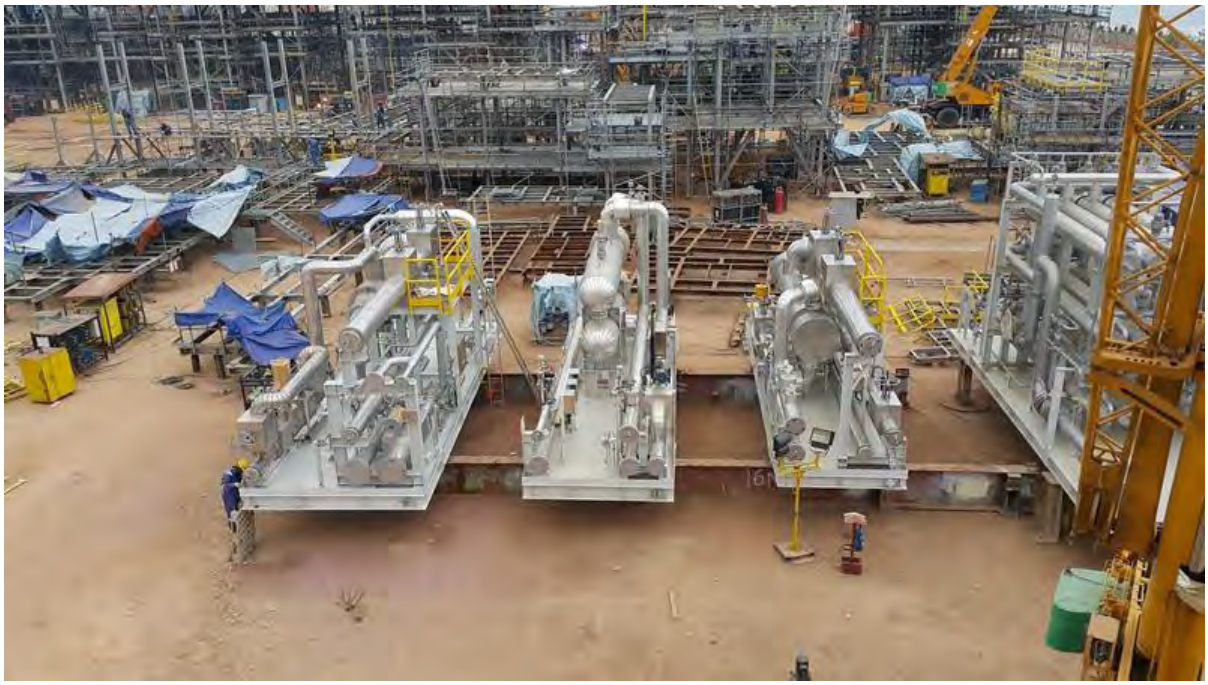
**11-PK-0851**

REGENERATION GAS HEATER SKID

11-PK-0861

## MEMBRANE PRE-HEATER SKID

**11-PK-0843**



**HEAT EXCHANGER SKIDS**

PRE-TREATMENT INLET SEPARATOR (11-V 0811)

PARTICLE FILTER (11-V 0841)

REGENERATION GAS SEPARATOR (11-V 0881)

$H_2S$ REMOVAL VESSEL (11-V 0897)

TSA SILICA GEL BED VESSEL (11-V 0813A)

TSA VESSEL (11-V 0813B) BEING PAINTED

TSA SILICA GEL BED VESSEL (11-V 0813C)

HOT OIL EXPANSION DRUM (11-V 0821)

REGENERATION GAS AIR COOLER (11-V 0871)

HOT OIL DRAIN DRUM (11-V 0829)


REGENERATION GAS AIR COOLER (11-V 0871)

H2S REMOVAL FILTER (11-V 0898)

# TABLE OF SHIPMENTS

## AGRU EQUIPMENT

**AL JOB No: 1.26013**

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | TOTAL NET WEIGHT (in KG) | | | **675,429** | From : | | **INDONESIA - EUROPE - USA** | | | | | |
| | | | | | | | TOTAL GROSS WEIGHT (in KG) | | | **816,046** | TOTAL No. of PACKAGES | | | **101** | | | | |
| | *Item No.* | *Qty* | *Unit* | *Supplier* | *Order No* | *Over Dimensions* | *N° Item* | *Equipment Designation* | *Incoterm* | *Place of collection* | *Ref. #* | *Length (cm)* | *Width (cm)* | *Height (cm)* | *Net Weight (kg)* | *Gross Weight (kg)* | *Revised Available Dates as of 12JAN2015* | |
| 1 | *11-A 0871* | *1* | *REGENERATION GAS AIR COOLER* | *PT HEAT EXCHANGERS INDONESIA* | | | | *AIR COOLER - FORCED DRAFT* | *EXW* | *BATAM, INDONESIA* | | *1,128* | *510* | *581* | *21,319* | *21,819* | Rdy for Shipmnt | 1 |
| 2 | *11-F 0841* | *1* | *PARTICLE FILTER* | *PT HEAT EXCHANGERS INDONESIA* | | | | *PRESSURE VESSEL* | *EXW* | *BATAM, INDONESIA* | | *455* | *171* | *169* | *8,100* | *8,508* | Rdy for Shipmnt | 2 |
| 3 | *11-F 0898* | *1* | *H2S FILTER* | *PT HEAT EXCHANGERS INDONESIA* | | | | *PRESSURE VESSEL* | *EXW* | *BATAM, INDONESIA* | | *405* | *37* | *76* | *1,606* | *1,626* | Rdy for Shipmnt | 3 |
| 4 | *11-V 0811* | *1* | *PRE-TREATMENT INLET SEPARATOR* | *PT HEAT EXCHANGERS INDONESIA* | | | | *PRESSURE VESSEL* | *EXW* | *BATAM, INDONESIA* | | *692* | *238* | *275* | *19,900* | *20,633* | Rdy for Shipmnt | 4 |
| 5 | *11-V 0813 A* | *1* | *TSA SILICA GEL BED VESSELS* | *PT HEAT EXCHANGERS INDONESIA* | | | | *PRESSURE VESSEL* | *EXW* | *BATAM, INDONESIA* | | *1,040* | *313* | *335* | *59,500* | *60,863* | Rdy for Shipmnt | 5 |
| 6 | *11-V 0813 B* | *1* | *TSA SILICA GEL BED VESSELS* | *PT HEAT EXCHANGERS INDONESIA* | | | | *PRESSURE VESSEL* | *EXW* | *BATAM, INDONESIA* | | *1,040* | *313* | *335* | *59,500* | *60,863* | Rdy for Shipmnt | 6 |
| 7 | *11-V 0813 C* | *1* | *TSA SILICA GEL BED VESSELS* | *PT HEAT EXCHANGERS INDONESIA* | | | | *PRESSURE VESSEL* | *EXW* | *BATAM, INDONESIA* | | *1,040* | *313* | *335* | *59,500* | *60,863* | Rdy for Shipmnt | 7 |
| 8 | *11-V 0881* | *1* | *REGENERATION GAS SEPARATOR* | *PT HEAT EXCHANGERS INDONESIA* | | | | *PRESSURE VESSEL* | *EXW* | *BATAM, INDONESIA* | | *446* | *167* | *146* | *6,400* | *6,707* | Rdy for Shipmnt | 8 |
| 9 | *11-V 0897* | *1* | *H2S REMOVAL VESSEL* | *PT HEAT EXCHANGERS INDONESIA* | | | | *PRESSURE VESSEL* | *EXW* | *BATAM, INDONESIA* | | *1,064* | *238* | *216* | *28,150* | *28,770* | Rdy for Shipmnt | 9 |
| 10 | *11-V 0821* | *1* | *HOT OIL EXPANSION TANK* | *PT HEAT EXCHANGERS INDONESIA* | | | | *PRESSURE VESSEL* | *EXW* | *BATAM, INDONESIA* | | *524* | *188* | *216* | *4,500* | *4,520* | Rdy for Shipmnt | 10 |
| 11 | *11-V 0829* | *1* | *HOT OIL DRAIN DRUM* | *PT HEAT EXCHANGERS INDONESIA* | | | | *PRESSURE VESSEL* | *EXW* | *BATAM, INDONESIA* | | *712* | *263* | *326* | *8,100* | *8,120* | Rdy for Shipmnt | 11 |
| 12 | | | | | | | | | | | | | | | | | | 12 |
| 13 | *11-PK 0813A* | *1* | *TSA INLET VALVE SKID* | *PT VME* | | | | *SKID MODULE* | *EXW* | *BATAM, INDONESIA* | | *1,198* | *418* | *408* | *38,320* | *38,320* | Rdy for Shipmnt | 13 |
| 14 | *11-PK 0813B* | *1* | *TSA OUTLET VALVE SKID* | *PT VME* | | | | *SKID MODULE* | *EXW* | *BATAM, INDONESIA* | | *1,200* | *420* | *393* | *38,280* | *38,280* | Rdy for Shipmnt | 14 |
| 15 | *11-PK 0851* | *1* | *REGEN GAS ECONOMIZER SKID* | *PT VME* | | | | *SKID MODULE (INCL.11-E 0851 A&B)* | *EXW* | *BATAM, INDONESIA* | | *900* | *300* | *456* | *28,100* | *28,100* | Rdy for Shipmnt | 15 |
| 16 | *11-PK 0861* | *1* | *REGEN GAS HEATER SKID* | *PT VME* | | | | *SKID MODULE (INCL.11-E 0861)* | *EXW* | *BATAM, INDONESIA* | | *900* | *250* | *375* | *24,690* | *24,690* | Rdy for Shipmnt | 16 |
| 17 | *11-PK 0843* | *1* | *MEMBRANE PREHEATER SKID* | *PT VME* | | | | *SKID MODULE (INCL.11-E 0843)* | *EXW* | *BATAM, INDONESIA* | | *1,000* | *300* | *410* | *33,640* | *33,640* | Rdy for Shipmnt | 17 |
| 18 | *11-F 0891A* | *1* | *MEMBRANE SKID* | *PT VME* | | | | *SKID MODULE* | *EXW* | *BATAM, INDONESIA* | | *1,000* | *420* | *580* | *45,050* | *45,050* | Rdy for Shipmnt | 18 |
| 19 | *11-F 0891B* | *1* | *MEMBRANE SKID* | *PT VME* | | | | *SKID MODULE* | *EXW* | *BATAM, INDONESIA* | | *1,000* | *420* | *580* | *44,950* | *44,950* | Rdy for Shipmnt | 19 |
| 20 | *11-F 0891C* | *1* | *MEMBRANE SKID* | *PT VME* | | | | *SKID MODULE* | *EXW* | *BATAM, INDONESIA* | | *1,000* | *420* | *580* | *44,950* | *44,950* | Rdy for Shipmnt | 20 |
| 21 | *11-F 0891D* | *1* | *MEMBRANE SKID* | *PT VME* | | | | *SKID MODULE* | *EXW* | *BATAM, INDONESIA* | | *1,000* | *420* | *580* | *44,950* | *44,950* | Rdy for Shipmnt | 21 |
| 22 | | | | | | | | | | | | | | | | | | 22 |
| 23 | *11-PK 0823* | *1* | *HOT OIL SYSTEM FIRED HEATER & BURNER* | *SIGMA-THERMAL* | | | | *SKID MODULE* | *EXW* | *MARIETTA, GEORGIA, USA* | | *889* | *384* | *374* | *28,869* | *28,869* | Rdy for Shipmnt | 23 |
| 24 | | | *EXHAUST STACK* | *SIGMA-THERMAL* | | | | | *EXW* | *MARIETTA, GEORGIA, USA* | | *762* | *135* | *112* | *1,628* | *1,628* | Rdy for Shipmnt | 24 |
| 25 | | | *AIR BLOWER / SILENCER PKG.* | *SIGMA-THERMAL* | | | | | *EXW* | *MARIETTA, GEORGIA, USA* | | *304* | *405* | *127* | *1,313* | *1,313* | Rdy for Shipmnt | 25 |
| 26 | | | *FUEL TRAIN* | *SIGMA-THERMAL* | | | | | *EXW* | *MARIETTA, GEORGIA, USA* | | *495* | *157* | *197* | *1,361* | *1,364* | Rdy for Shipmnt | 26 |
| 27 | | | *CONTROL PANEL* | *SIGMA-THERMAL* | | | | | *EXW* | *MARIETTA, GEORGIA, USA* | | *183* | *76* | *244* | *400* | *400* | Rdy for Shipmnt | 27 |
| 28 | *11-PK 0827* | *1* | *HOT OIL SYSTEM CIRCULATION PUMPS & FILTER SKID* | *SIGMA-THERMAL* | | | | *SKID MODULE* | *EXW* | *MARIETTA, GEORGIA, USA* | | *581* | *412* | *336* | *11,448* | *11,448* | Rdy for Shipmnt | 28 |
| 30 | | | *CO2 SNUFFING SYSTEM* | *CENTURY FIRE PROTECTION* | | | | *SKID MODULE* | *EXW* | *MARIETTA, GEORGIA, USA* | | | | | | | Rdy for Shipmnt | 30 |
| 31 | | | | | | | | | | | | | | | | | | 31 |
| 42 | | *26* | *MEMBRANE MODULES* | *AIR LIQUIDE-MEDAL* | | | | *MEMBRANE MODULES 6 MODULES PER CRATE, 26 CRATES TOTAL* | *EXW* | *NEWPORT, DELAWARE, USA* | | *170.2* | *147.3* | *129.5* | *680* | *17680* | Rdy for Shipmnt | 42 |
| 43 | | *1* | *EXTENSION TUBE ASSEMBLIES* | *AIR LIQUIDE-MEDAL* | | | | *44 PER CRATE, 1 CRATE TOTAL* | *EXW* | *NEWPORT, DELAWARE, USA* | | *170.2* | *147.3* | *129.5* | *800* | *800* | Rdy for Shipmnt | 43 |
| 44 | | *1* | *DUMMY TUBES* | *AIR LIQUIDE-MEDAL* | | | | *10 PER CRATE, 1 CRATE TOTAL* | *EXW* | *NEWPORT, DELAWARE, USA* | | *305* | *61* | *71* | *450* | *450* | Rdy for Shipmnt | 44 |
| 45 | | | | | | | | | | | | | | | | | | 45 |
| 46 | | *1* | *UNIT CONTROL PANEL* | *KEAS* | | | | *ELECTRICAL PANEL* | *EXW* | *Batam, Indonesia* | | *152* | *112* | *232* | *850* | *950* | Rdy for Shipmnt | 46 |
| 47 | | *3* | *BOX CONTAINING - MATERIAL PACKING* | *KEAS* | | | | *ELECTRICAL PANEL* | *EXW* | *Batam, Indonesia* | | *85* | *85* | *85* | *120* | *210* | Rdy for Shipmnt | |
| 50 | | | | | | | | | | | | | | | | | | 50 |
| 51 | *11-P 0833* | *1* | *HOT OIL DRAIN PUMP / MOTOR ASSEMBLY* | *FLOWSERVE* | | | | *Crate* | *EXW* | *Flowserve Austria* | | | | | | | Rdy for Shipmnt | 51 |
| 52 | | | | | | | | | | | | | | | | | | 52 |
| 53 | | *1* | *PRESSURE RELIEF VALVES* | *FARRIS* | | | | *Crate* | *EXW* | *VME-Tyler, TX* | | | | | | | Rdy for Shipmnt | 53 |
| 54 | | | | | | | | | | | | | | | | | | 54 |
| 55 | *Vessel Plat #1* | *1* | *VESSEL ACCESS PLATFORMS FOR (11-V-0897)* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *468* | *280* | *272* | *1,338* | *1,338* | Rdy for Shipmnt | 55 |
| 56 | *Vessel Plat #2* | *1* | *VESSEL ACCESS PLATFORMS FOR (11-V-0897)* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *315* | *315* | *210* | *1,400* | *1,400* | Rdy for Shipmnt | 56 |
| 57 | *Vessel Plat #3* | *1* | *VERTICAL LADDER FOR (11-V-0897)* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *1,120* | *84* | *84* | *365* | *365* | Rdy for Shipmnt | 57 |
| 58 | *Vessel Plat #4* | *3* | *PLATFORMS @ ELEVATION 2133* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *500* | *224* | *254* | *1,214* | *1,214* | Rdy for Shipmnt | 58 |
| 59 | *Vessel Plat #5* | *3* | *VESSEL ACCESS PLATFORMS FOR (11-V-0813A/B/C)* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *300* | *300* | *200* | *1,635* | *1,635* | Rdy for Shipmnt | 59 |
| 60 | *Vessel Plat #6* | *3* | *VERTICAL LADDER FOR (11-V-0813A/B/C )* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *1,000* | *70* | *70* | *335* | *335* | Rdy for Shipmnt | 60 |
| 61 | *Vessel Plat #7* | *1* | *VESSEL ACCESS PLATFORMS FOR (11-V-0811)* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *489* | *250* | *278* | *1,820* | *1,820* | Rdy for Shipmnt | 61 |
| 62 | *Vessel Plat #8* | *1* | *VERTICAL LADDER FOR (11-V-0811 )* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *288* | *70* | *26* | *146* | *146* | Rdy for Shipmnt | 62 |
| 63 | *Vessel Plat #9* | *1* | *VESSEL ACCESS PLATFORMS FOR (11-V-0881)* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *314* | *170* | *129* | *525* | *525* | Rdy for Shipmnt | 63 |
| 64 | *Vessel Plat #10* | *1* | *VESSEL ACCESS PLATFORMS FOR (11-V-0881)* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *345* | *342* | *129* | *1,003* | *1,003* | Rdy for Shipmnt | 64 |
| 65 | | | | | | | | | | | | | | | | | | 65 |
| 66 | *Box #1* | *1* | *CRATE CONTANING LIFTING GEAR FOR 11-PK-0813 A/B* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *380* | *210* | *70* | *690* | *850* | Rdy for Shipmnt | 66 |
| 67 | *Box #2* | *1* | *CRATE CONTANING LIFTING GEAR FOR 11-F-0891A/B/C/B* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *208* | *213* | *73* | *306* | *410* | Rdy for Shipmnt | 67 |
| 68 | *Box #3* | *1* | *CRATE CONTANING LIFTING GEAR FOR -11-PK-0843* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *208* | *157* | *73* | *219* | *320* | Rdy for Shipmnt | 68 |
| 69 | *Box #4* | *1* | *CRATE CONTANING LIFTING GEAR FOR -11-PK-0851* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *208* | *213* | *73* | *199* | *300* | Rdy for Shipmnt | 69 |
| 70 | *Box #5* | *1* | *CRATE CONTANING LIFTING GEAR FOR -11-PK-0861* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *208* | *208* | *73* | *235* | *340* | Rdy for Shipmnt | 70 |
| 71 | *Box #6* | *1* | *CRATE CONTANING LIFTING GEAR FOR -11-A-0871* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *153* | *126* | *60* | *41* | *90* | Rdy for Shipmnt | 71 |
| 72 | *Box #7* | *1* | *BOX CONTANING LIFTING GEAR* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *108* | *77* | *60* | *372* | *410* | Rdy for Shipmnt | 72 |
| 73 | *Box #8* | *1* | *PALLET CONTAINING SPREADER BAR* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *5,500* | *50* | *35* | *385* | *445* | Rdy for Shipmnt | 73 |
| 74 | *Box #9* | *1* | *PALLET CONTAINING SPREADER BAR* | *PT VME* | | | | *Crate* | *EXW* | *BATAM, INDONESIA* | | *5,100* | *50* | *35* | *545* | *605* | Rdy for Shipmnt | 74 |

# TABLE OF SHIPMENTS
## AGRU EQUIPMENT

**AL JOB No: 1.26013**

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | TOTAL NET WEIGHT (in KG) | | | **675,429** | From : | | **INDONESIA - EUROPE - USA** | | | | | |
| | | | | | | | TOTAL GROSS WEIGHT (in KG) | | | **816,046** | TOTAL No. of PACKAGES | | | | | **101** | | |
| | Item No. | Qty | Unit | Supplier | Order No | Over Dimensions | N° Item | Equipment Designation | Incoterm | Place of collection | Ref. # | Length (cm) | Width (cm) | Height (cm) | Net Weight (kg) | Gross Weight (kg) | Revised Available Dates as of 12JAN2015 | |
| 75 | Box #10 | 1 | BOX CONTAINING CONTROL VALVE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 188 | 137 | 71 | 280 | 410 | Rdy for Shipmnt | 75 |
| 76 | Box #11 | 1 | BOX CONTAINING CONTROL VALVE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 132 | 112 | 69 | 255 | 345 | Rdy for Shipmnt | 76 |
| 77 | Box #12 | 1 | BOX CONTAINING CONTROL VALVE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 113 | 54 | 66 | 55 | 98 | Rdy for Shipmnt | 77 |
| 78 | Box #13 | 1 | BOX CONTAINING CONTROL VALVE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 113 | 54 | 66 | 55 | 98 | Rdy for Shipmnt | 78 |
| 79 | Box #14 | 1 | BOX CONTAINING CONTROL VALVE AND PANEL ASSEMBLY | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 118 | 137 | 71 | 280 | 410 | Rdy for Shipmnt | 79 |
| 80 | Box #15 | 1 | BOX CONTAINING CONTROL VALVE AND PANEL ASSEMBLY | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 118 | 137 | 71 | 280 | 410 | Rdy for Shipmnt | 80 |
| 81 | Box #16 | 1 | BOX CONTAINING MANUAL VALVES | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 104 | 92 | 144 | 1,038 | 1,185 | Rdy for Shipmnt | 81 |
| 82 | Box #17 | 1 | BOX CONTAINING MANUAL VALVES | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 104 | 92 | 144 | 1,038 | 1,185 | Rdy for Shipmnt | 82 |
| 83 | Box #18 | 1 | BOX CONTAINING MANUAL VALVES | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 104 | 92 | 144 | 1,038 | 1,185 | Rdy for Shipmnt | 83 |
| 84 | Box #19 | 1 | BOX CONTAINING MANUAL VALVES | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 104 | 92 | 144 | 1,038 | 1,185 | Rdy for Shipmnt | 84 |
| 85 | Box #20 | 1 | BOX CONTAINING MANUAL VALVES | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 110 | 98 | 150 | 1,038 | 1,200 | Rdy for Shipmnt | 85 |
| 86 | Box #21 | 1 | BOX CONTAINING MANUAL VALVES | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 112 | 78 | 120 | 530 | 610 | Rdy for Shipmnt | 86 |
| 87 | Box #22 | 1 | BOX CONTAINING MANUAL VALVES | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 112 | 78 | 120 | 530 | 610 | Rdy for Shipmnt | 87 |
| 88 | Box #23 | 1 | BOX CONTAINING MANUAL VALVES | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 76 | 76 | 104 | 265 | 325 | Rdy for Shipmnt | 88 |
| 89 | Box #24 | 1 | BOX CONTAINING MANUAL VALVES | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 76 | 76 | 104 | 265 | 325 | Rdy for Shipmnt | 89 |
| 90 | Box #25 | 1 | BOX CONTAINING MANUAL VALVES | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 76 | 76 | 104 | 265 | 325 | Rdy for Shipmnt | 90 |
| 91 | Box #26 | 1 | BOX CONTAINING CONTROL VALVE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 229 | 137 | 76 | 450 | 660 | Rdy for Shipmnt | 91 |
| 92 | Box #27 | 1 | BOX CONTAINING MANUAL VALVES | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 110 | 101 | 75 | 266 | 336 | Rdy for Shipmnt | 92 |
| 93 | Box #28 | 1 | BOX CONTAINING MANUAL VALVES | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 128 | 128 | 67 | 495 | 605 | Rdy for Shipmnt | 93 |
| 94 | Box #29 | 1 | BOX CONTAINING PANEL ASSEMBLY | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 132 | 112 | 58 | 70 | 155 | Rdy for Shipmnt | 94 |
| 95 | Box #30 | 1 | BOX CONTAINING CONTROL VALVE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 97 | 93 | 198 | 1,265 | 1,385 | Rdy for Shipmnt | 95 |
| 96 | Box #31 | 1 | BOX CONTAINING CONTROL VALVE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 226 | 136 | 75 | 450 | 660 | Rdy for Shipmnt | 96 |
| 97 | Box #32 | 1 | BOX CONTAINING MANUAL VALVE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 131 | 260 | 123 | 985 | 1,145 | Rdy for Shipmnt | 97 |
| 98 | Box #33 | 1 | BOX CONTAINING CONTROL VALVE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 186 | 60 | 62 | 360 | 440 | Rdy for Shipmnt | 98 |
| 99 | Box #34 | 1 | BOX CONTAINING CONTROL VALVE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 226 | 69 | 67 | 460 | 585 | Rdy for Shipmnt | 99 |
| 100 | Box #35 | 1 | BOX CONTAINING MANUAL VALVE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 72 | 71 | 44 | 145 | 165 | Rdy for Shipmnt | 100 |
| 101 | Box #36 | 1 | BOX CONTAINING DOUBLE BLOCK AND BLEED VALVE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 109 | 75 | 55 | 654 | 694 | Rdy for Shipmnt | 101 |
| 102 | Box #37 | 1 | BOX CONTAINING LEVEL GAUGE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 170 | 65 | 55 | 105 | 155 | Rdy for Shipmnt | 102 |
| 103 | Box #38 | 1 | BOX CONTAINING LEVEL TRANSMITTER | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 158 | 99 | 119 | 40 | 140 | Rdy for Shipmnt | 103 |
| 104 | Box #39 | 1 | BOX CONTAINING MANUAL BALL VALVE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 107 | 57 | 47 | 294 | 344 | Rdy for Shipmnt | 104 |
| 105 | Box #40 | 1 | BOX CONTAINING MANUAL BALL VALVE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 107 | 97 | 83 | 429 | 479 | Rdy for Shipmnt | 105 |
| 106 | Box #41 | 1 | BOX CONTAINING MANUAL PRESSURE SAFETY VALVE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 92 | 62 | 82 | 43 | 65 | Rdy for Shipmnt | 106 |
| 107 | Box #42 | 1 | BOX CONTAINING INSTRUMENTS TRANSMITTER | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 106 | 67 | 69 | 26 | 76 | Rdy for Shipmnt | 107 |
| 108 | Box #43 | 1 | BOX CONTAINING THERMOWELLS -TW/TE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 106 | 47 | 49 | 54 | 104 | Rdy for Shipmnt | 108 |
| 109 | Box #44 | 1 | BOX CONTAINING DUPLEX PIPE SPOOLS | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 106 | 47 | 56 | 326 | 516 | Rdy for Shipmnt | 109 |
| 110 | Box #45 | 1 | BOX CONTAINING MANUAL VALVES | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 106 | 47 | 56 | 226 | 276 | Rdy for Shipmnt | 110 |
| 111 | Box #46 | 1 | BOX CONTAINING PRESSURE SAFETY VALVE | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 110 | 90 | 70 | 90 | 130 | Rdy for Shipmnt | 111 |
| 112 | Box #47 | 1 | BOX CONTAINING INSTALLATION MATERIALS FOR TSA | PT VME | | | | Crate | EXW | BATAM, INDONESIA | | 50 | 50 | 30 | 150 | 185 | Rdy for Shipmnt | 112 |

TOTAL WEIGHT 695,830 724,091

**Notes:**

1. These are ship loose items directly to site. Not a blocking point for any other deliverables
2. These items are currently under extensive review with SIGMA
3. RFSC submitted. Please note CHANGE OF DELIVERY ADDRESS from Germany to Pasadena, Texas, USA in the "Pick-Up Addresses" tab. Monthly storage costs will be provided week of Feb-08