Varec Biogas Digester Gas Safety and Handling Equipment

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BIOGAS

Biogas Definitions

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Biogas Systems

Important Design or Sizing Parameters

1. Total gas production or gas flow rate = approx 15 cubic feet of gas/lb of VSS destroyed
2. Biogas composition
3. WEF MOP 8, 1998 edition
   - Maximum velocity = 12 fps
4. NFPA 820, 2012 edition

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Biogas Systems

Important Design or Sizing Parameters

5. **Local Standards, e.g., 10-State Standard**

   Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Managers (GLUMRB)-Recommended Standards for Wastewater Treatment Facilities(10-State Standard).

   Member States: **ILLINOIS, NEW YORK, INDIANA, OHIO,IOWA, ONTARIO, CANADA, MICHIGAN, PENNSYLVANIA, MINNESOTA, WISCONSIN**

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Waste Gas Burner Header

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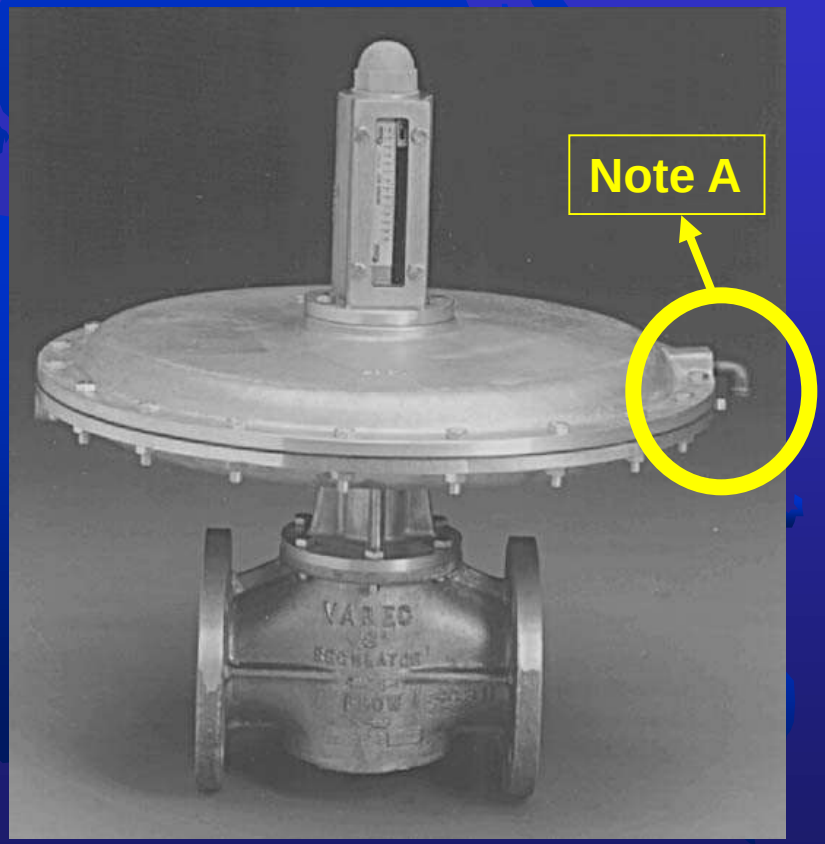
386 Series Back Pressure Regulator

Operation

- Controls upstream pressure.
- Valve Remains Closed Until Gas Pressure on Diaphragm Overcomes Spring Pressure.
- Unit Opens on Increasing Pressure.
- Valve Closes When Pressure Falls 10% Below Set Point
- Note A - *Fitted with a 3-way solenoid valve connected to burner control panel* – ON/OFF Capabilities.



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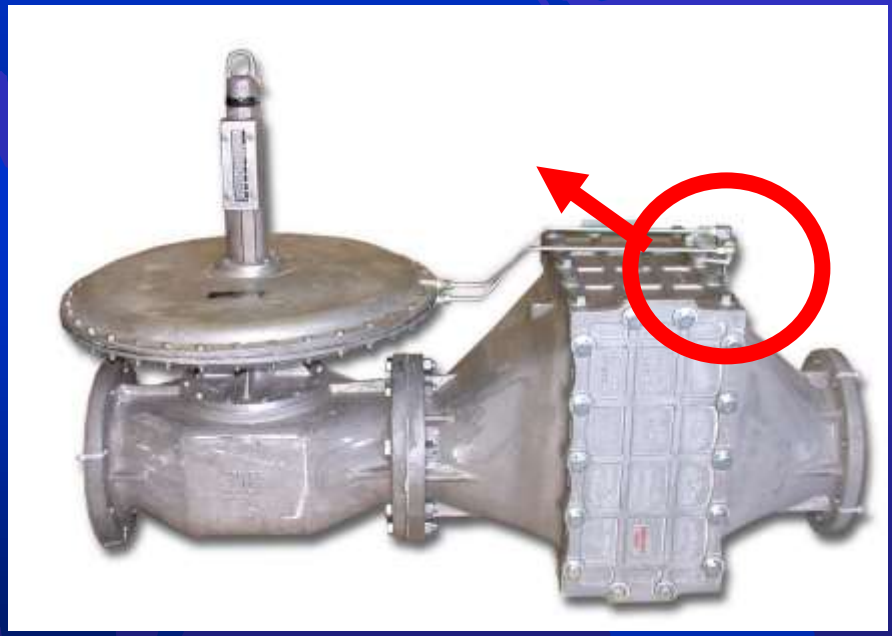
440 Series Pressure Relief & Flame Trap Assembly

Purpose

- Regulator is set to divert digester gas to the waste gas burner.
- Prevent flame propagation in case of flame flashback.
- THERMAL BYPASS SHUT-OFF VALVE Controls pressure applied on top and bottom portion of diaphragm.
- Closes regulator when fusible element melts.



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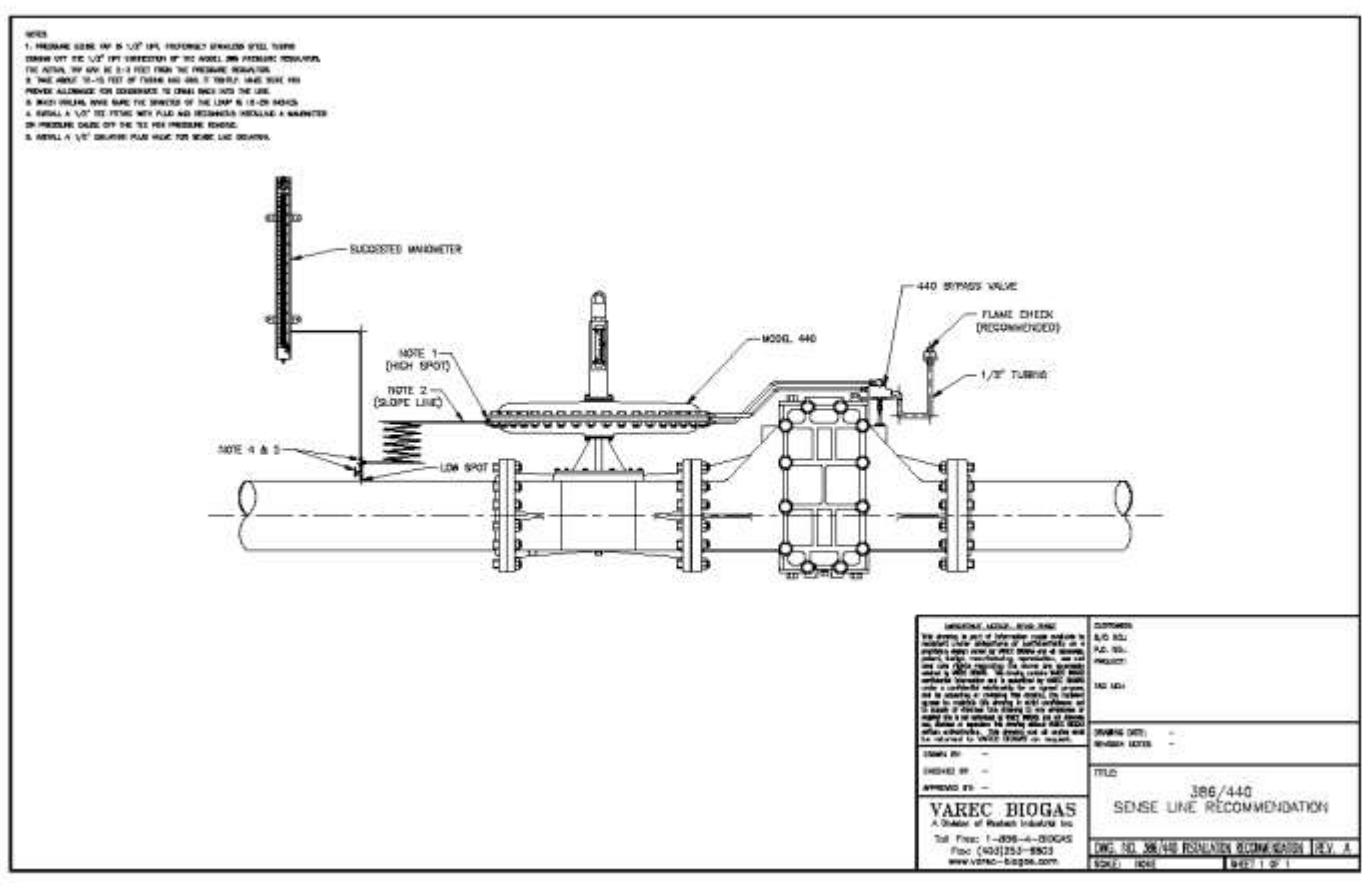
386/440 Series Back Pressure Regulator and/or Pressure Relief Regulator and Flame Trap Assembly

Installation Recommendation

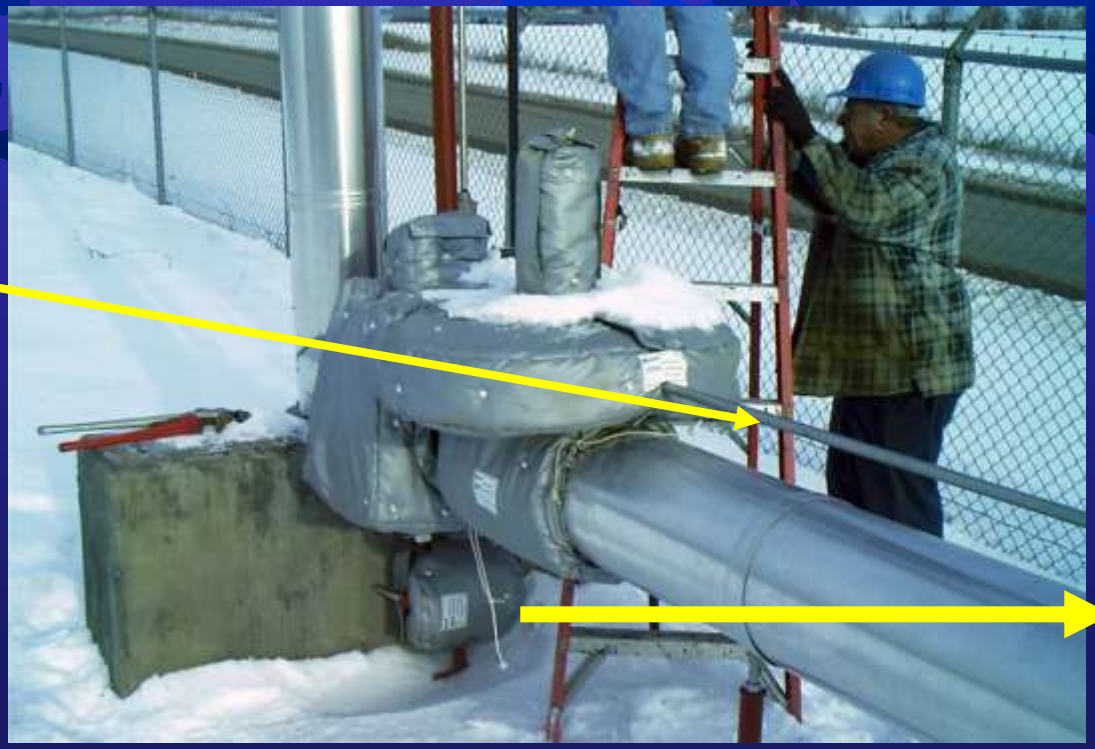


440 Series Pressure Relief & Flame Trap Assembly

Installation

1. Within 15 feet of the waste gas burner.
2. Outdoor installation - Insulating jacket (special) for cold weather protection

½” NPT pressure sense line (10 feet upstream).



Drip trap on ½” NPT drain connection with isolation plug valve

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450 Series Flame Trap Assembly

Purpose

Provides two types of protection from flashback fires

- Shuts-off Fuel Supply on Flame Flashback- thermal shut-off valve
- Prevents Propagation of Flame - Flame arrester

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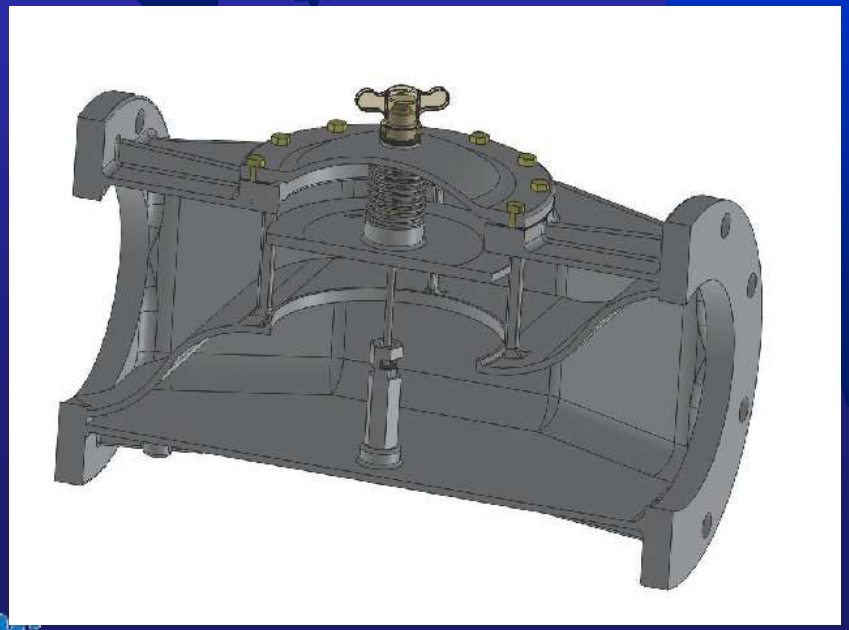
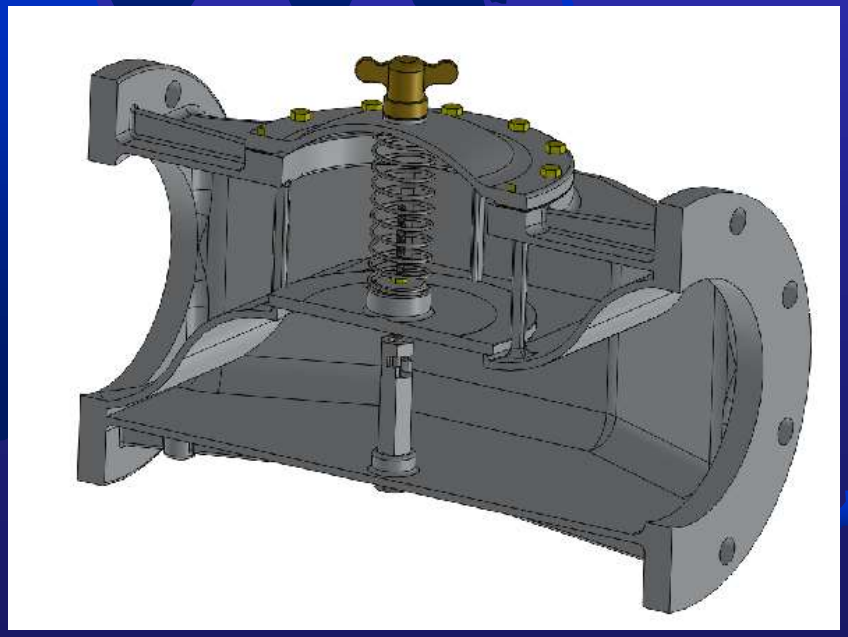
430 Series Thermal Shut-Off Valve

Purpose

Shuts-off Fuel Supply on Flame Flashback

- **Fusible element holds pallet in the open position.**
- **Element melts and forces the pallet closed.**





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450 Series Flame Trap Assembly

Installation

- Install within 15’ of potential flame source, i.e, flares, boilers/heat exchangers, engine-generators.
- Insulate from cold if installed outdoors

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5200 Flame Check

Purpose

- Prevents flame propagation in case of ashback.

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5200 Flame Check

Sample Installation

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Burners and Flares

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Flare Types

Candle-Stick flares

Enclosed flares

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Candle-Stick Flares

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239A/240 HOA Waste Gas Burner and Manual Cycling Ignition System

Operation

- Combust excess waste gas.
- Pilot Flame Ring
- 240 HOA Manual Cycling Ignition System
  - Igniter Assembly
  - Control Panel
  - Continuous pilot.
  - Spark duration/spark interval.

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239A/240 HOA Waste Gas Burner and Manual Cycling Ignition System

Installation

- Burner base pedestal. Make sure its properly supported.
- Secondary stack for 4”. 6” and 8”.
- Check:
  - Waste gas connection. Pipe slope to drain?
  - Igniter assembly installation. Correct igniter rod position?
  - Pilot gas piping and fitting. Isolation valve and flame check installed?
- Point-to-point wiring check.

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244W Series Waste Gas Burner with Automatic Pilot Ignition System

Operation

- Combust excess waste gas.
- Flamefront technology
- Continuous Pilot Nozzle at 30-45 deg. angle.
- Remote Start Automatic Pilot Ignition System
- Pilot gas supply pressure 4 in WC (100mm WC) – 14 in WC (350mm WC)
- Utilizes a low hP blower to pre-mix air and gas
- Pilot gas control components panel located max 70 feet away and 45-deg elbows allowed.

244WL

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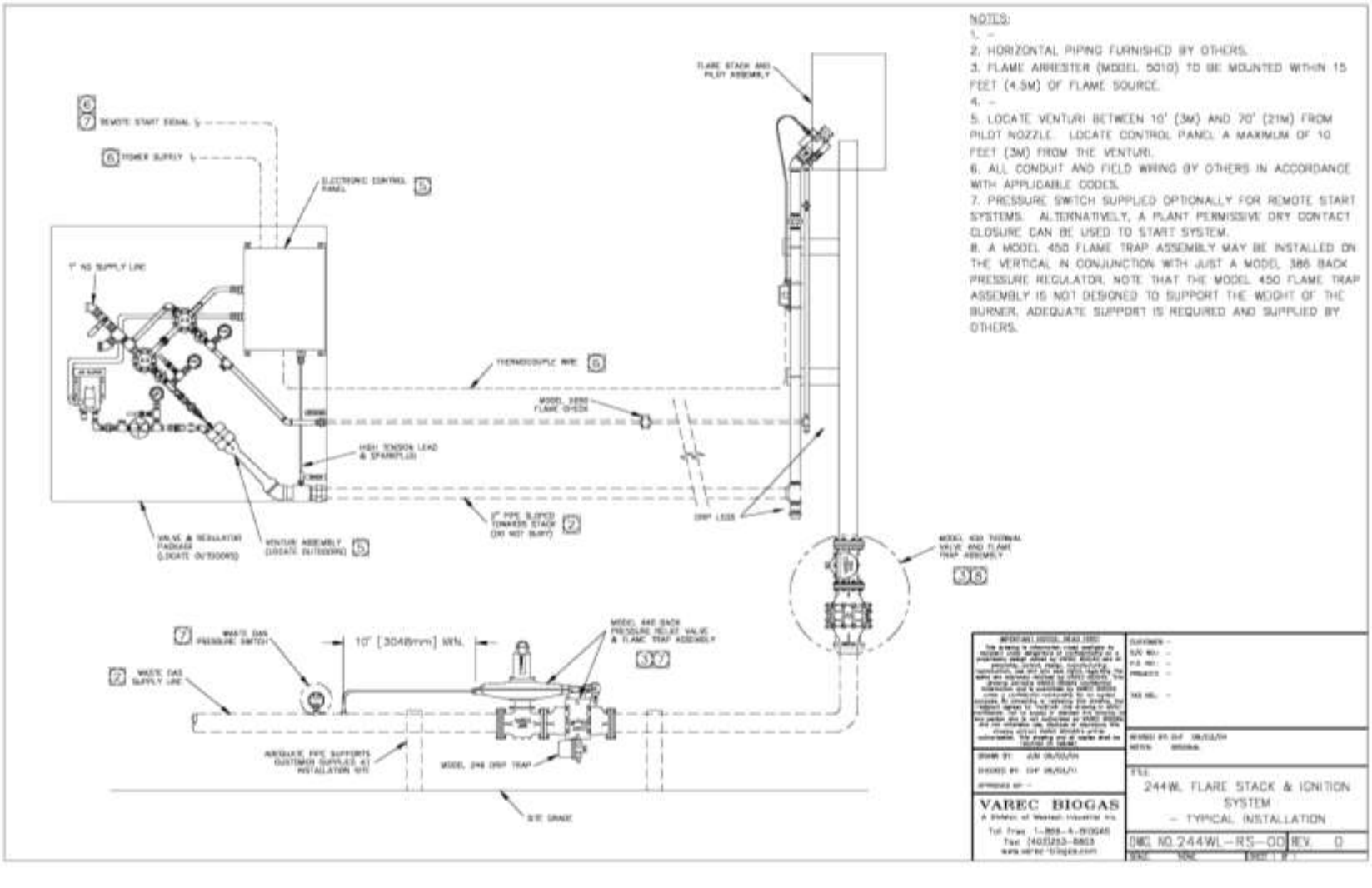
244WL Ignition System



Typical Installation for a 244WL with an automatic biogas pilot ignition system

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244W Series

Continuous flame nozzle at a 30-45 deg angle from vertical burner ensures that gas is ignited and burned at all flows (even fluctuating).

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244W Series vs. Competition

A look at the burner tip of a pilot nozzle runs parallel to the gas pipe after 9 years of operation.

A look at the burner tip of the 244WS Burner same timeframe.

Installation photos at City of Lubbock, TX (1999)

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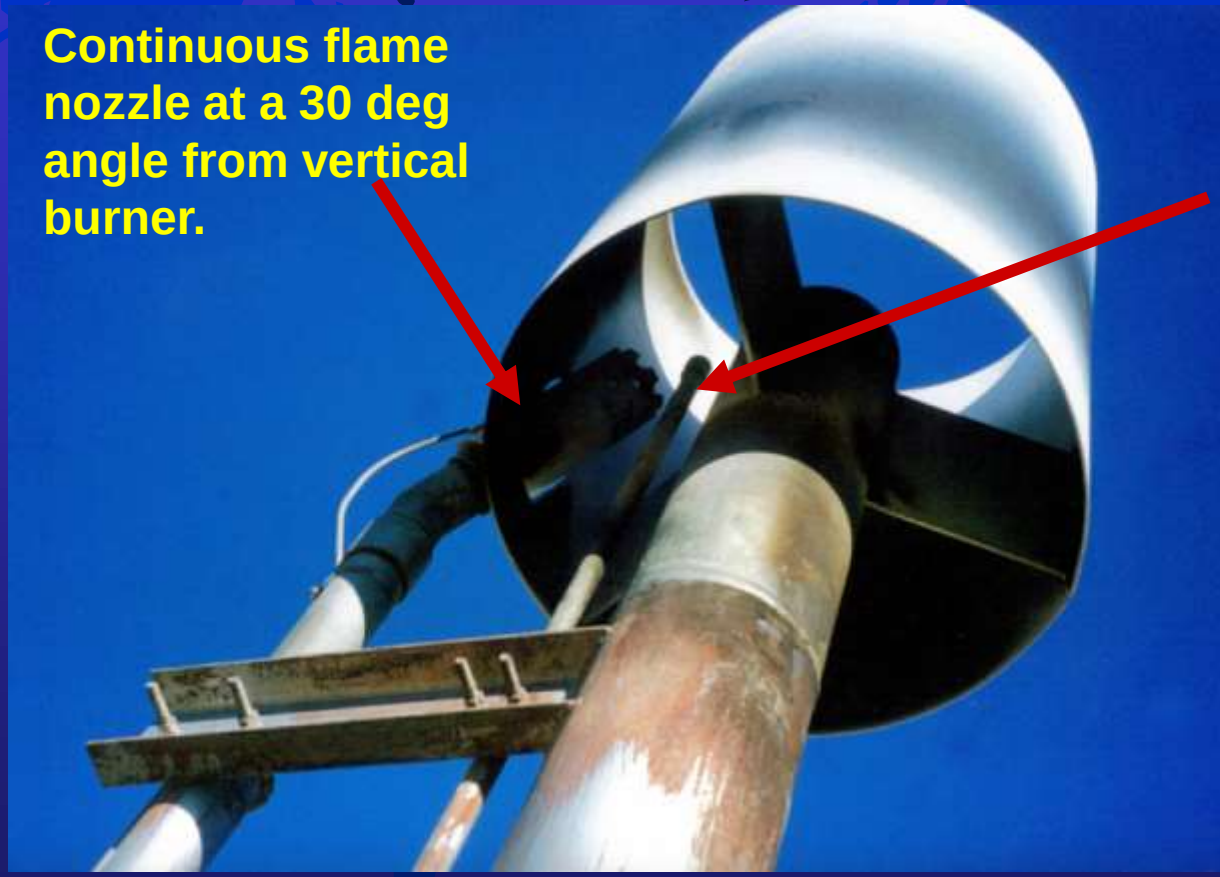
244W Series



Continuous flame nozzle at a 30 deg angle from vertical burner.

Flame retention nozzle – designed to “capture” the flamefront when it exits the continuous nozzle, thus lighting the pilot. Once the pilot is established, pilot gas flow to the retention nozzle is stopped.

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Enclosed Flares

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Enclosed Flares

Differences between Enclosed and Open

- No visible flame
- Guaranteed NOx, CO, and efficiency
- Low Radiant Heat

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Enclosed Flares

Destruction Removal Efficiency (DRE):

- **99.95% = .05% of the total combustible input to the flare is exiting the flare unburned.**

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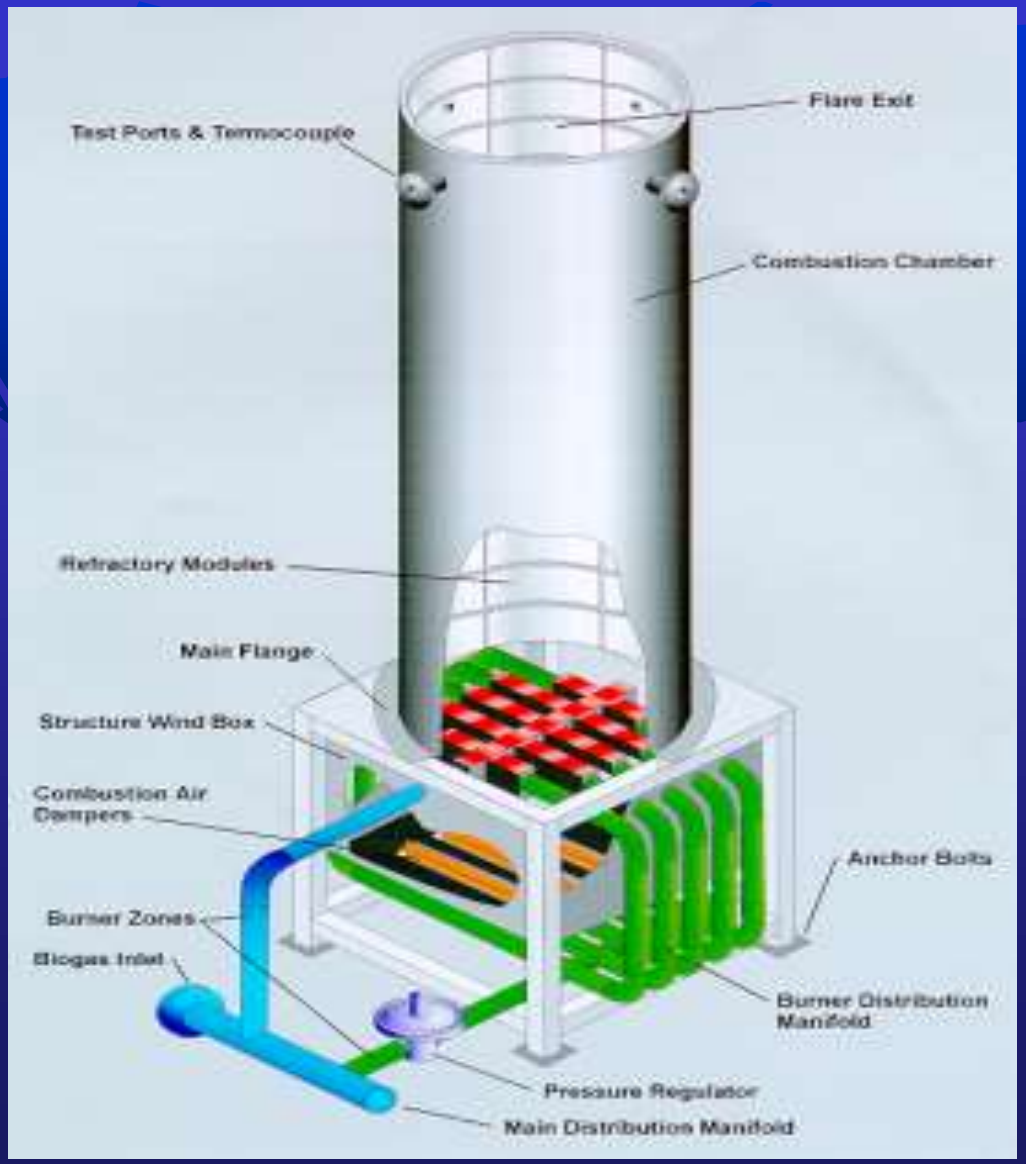
249 Series Enclosed Flare



Operation

- Refractory lined to retain heat and protect stack
- Air dampers modulate based on exit temperature
- Purge cycle and proof of closure valve to insure no gas build up in stack
- Size based on minimum and maximum flow rate.
- Time and temperature based.

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249 Series Installation

Boston Harbor Mod 3,
Boston, Massachusetts USA

F. Wayne Hill Water Resources Center, Gwinnett County, GA

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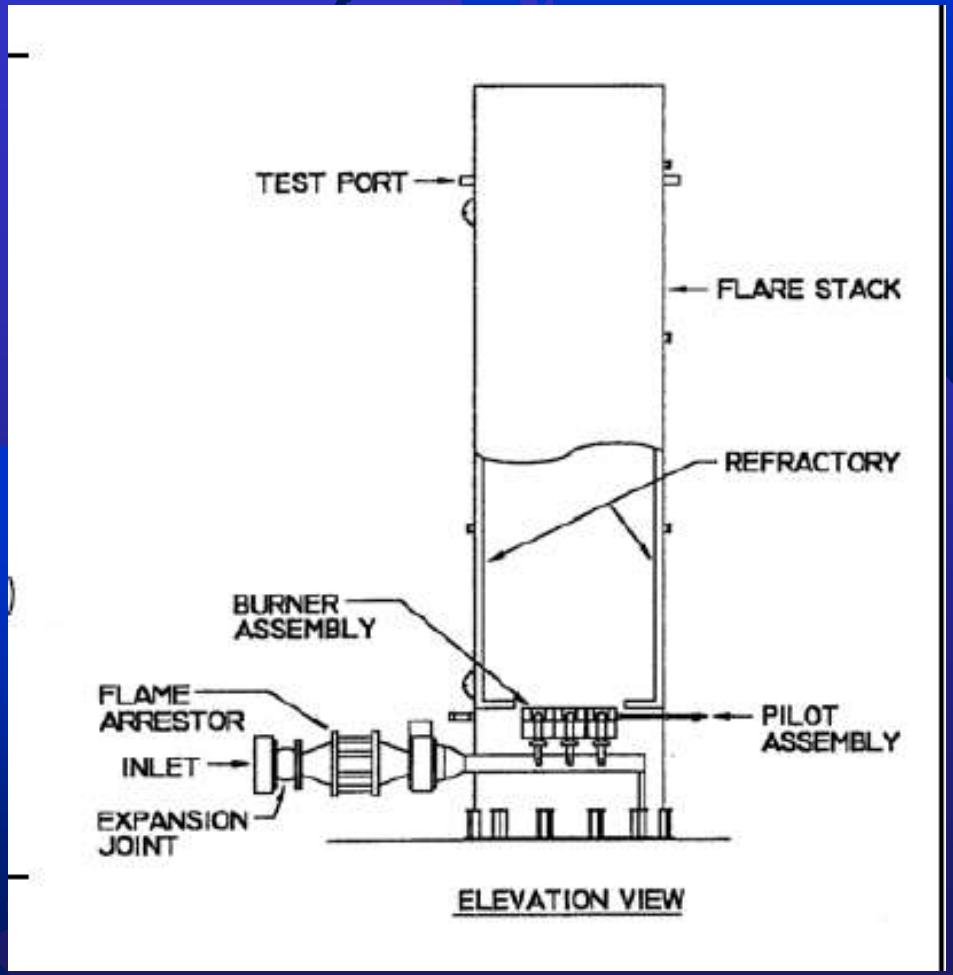
Enclosed Flares

Typical Enclosed Flare - using Natural Draft



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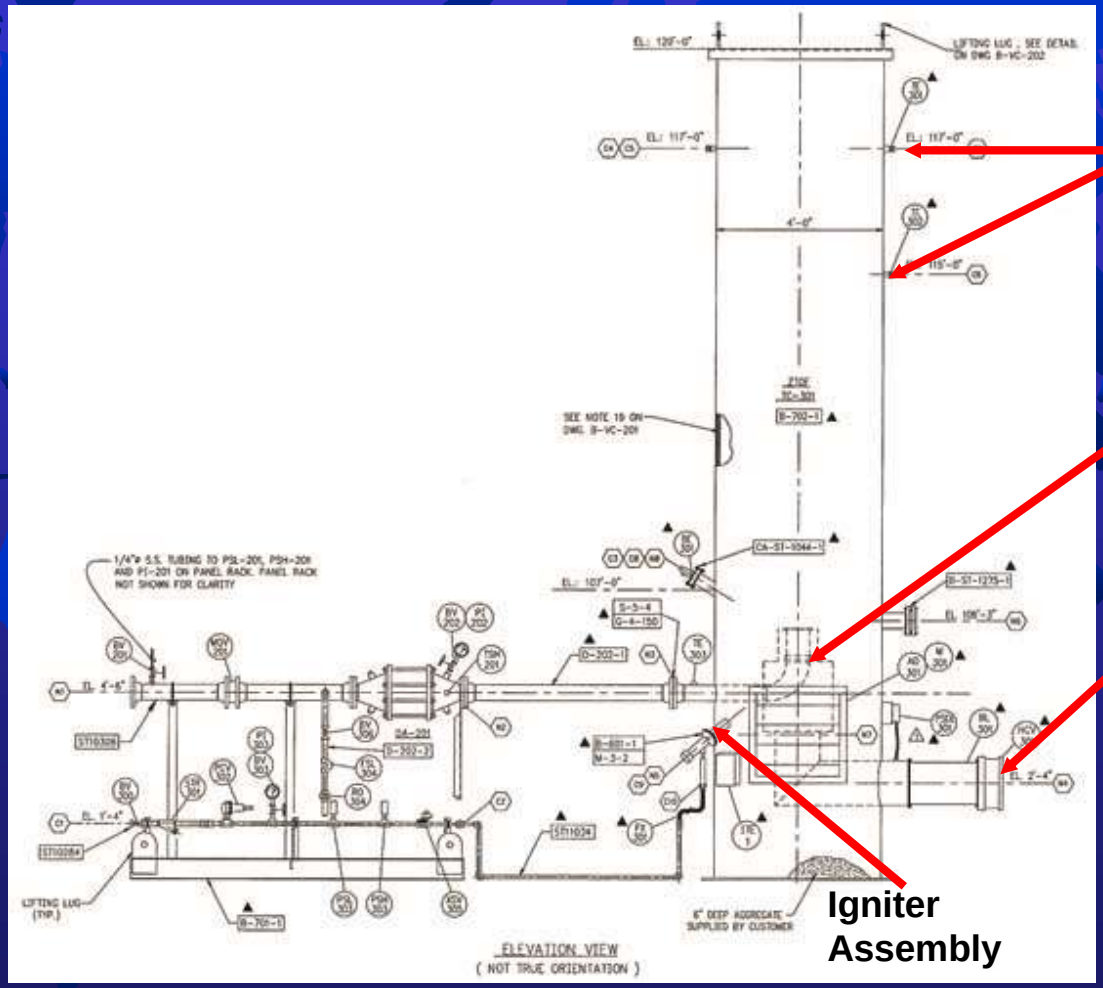
Enclosed Flares

Typical Enclosed Flare – Purge Blower



thermocouple

Burner

Air purge blower with flow meter and pressure regulator

Igniter Assembly

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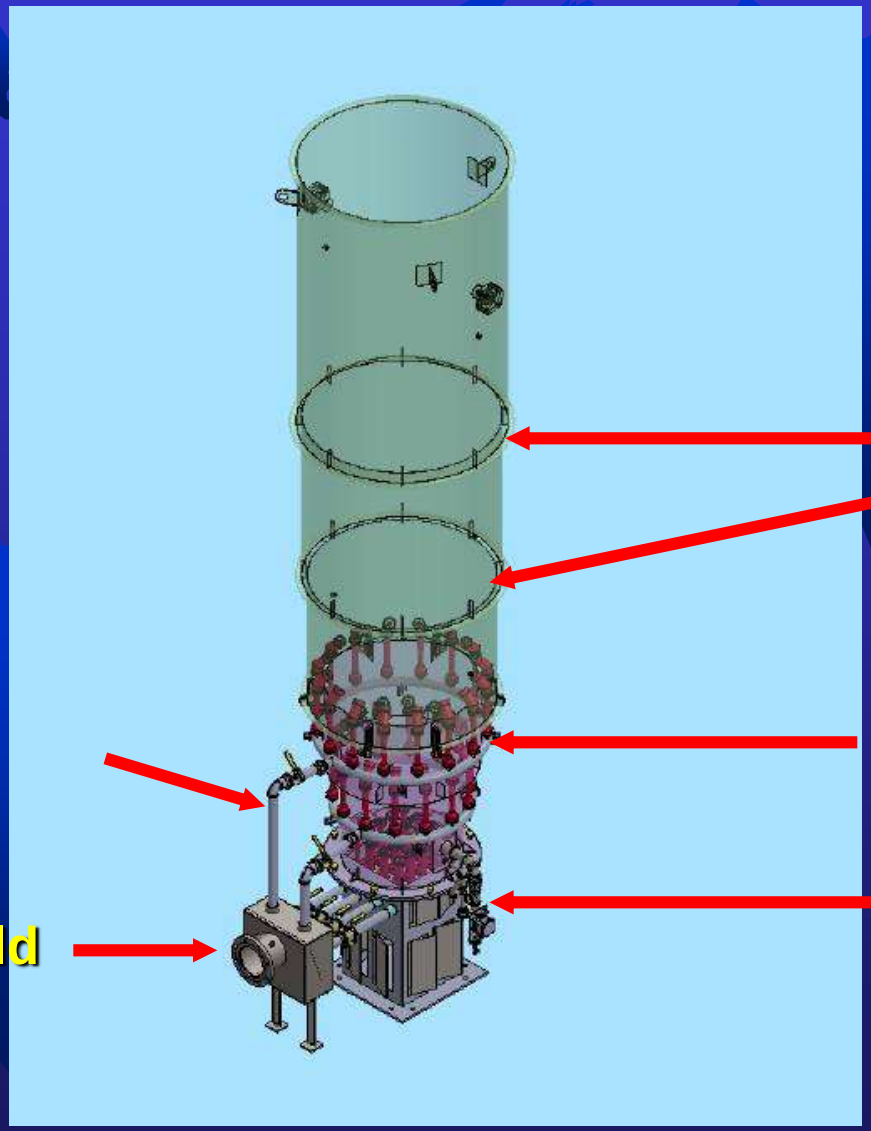
244E Enclosed Flare



Air gaps – Induces air naturally

Venturi Nozzle burners

Pilot gas piping

Burner zones

Burner manifold

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244E Enclosed Flare with Automatic Pilot Ignition System

Operation

- Combust excess waste gas.
- Guaranteed Destruction Removal Efficiency
- Same Ignition System as 244W. Either “S” , “G” or “L”
- Continuous Pilot Nozzle at 30-45 deg. angle.
- Remote Start Automatic Pilot Ignition System

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244E Enclosed Flare

Control Panel

Pilot Gas Valve
and Regulator Panel

Dual Pilot Lines

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244E Enclosed Flare

Burner Zones

Venturi-style nozzles

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244E Enclosed Flare

- Pilot Ignition System:
  - Thermocouple – Pilot flame sensing
  - Flamefront Technology
    1. Venturi-Driven System – 10 psig of supply pressure
    2. Low pressure pilot gas system, Digester Gas or Natural Gas, 5 psig and lower

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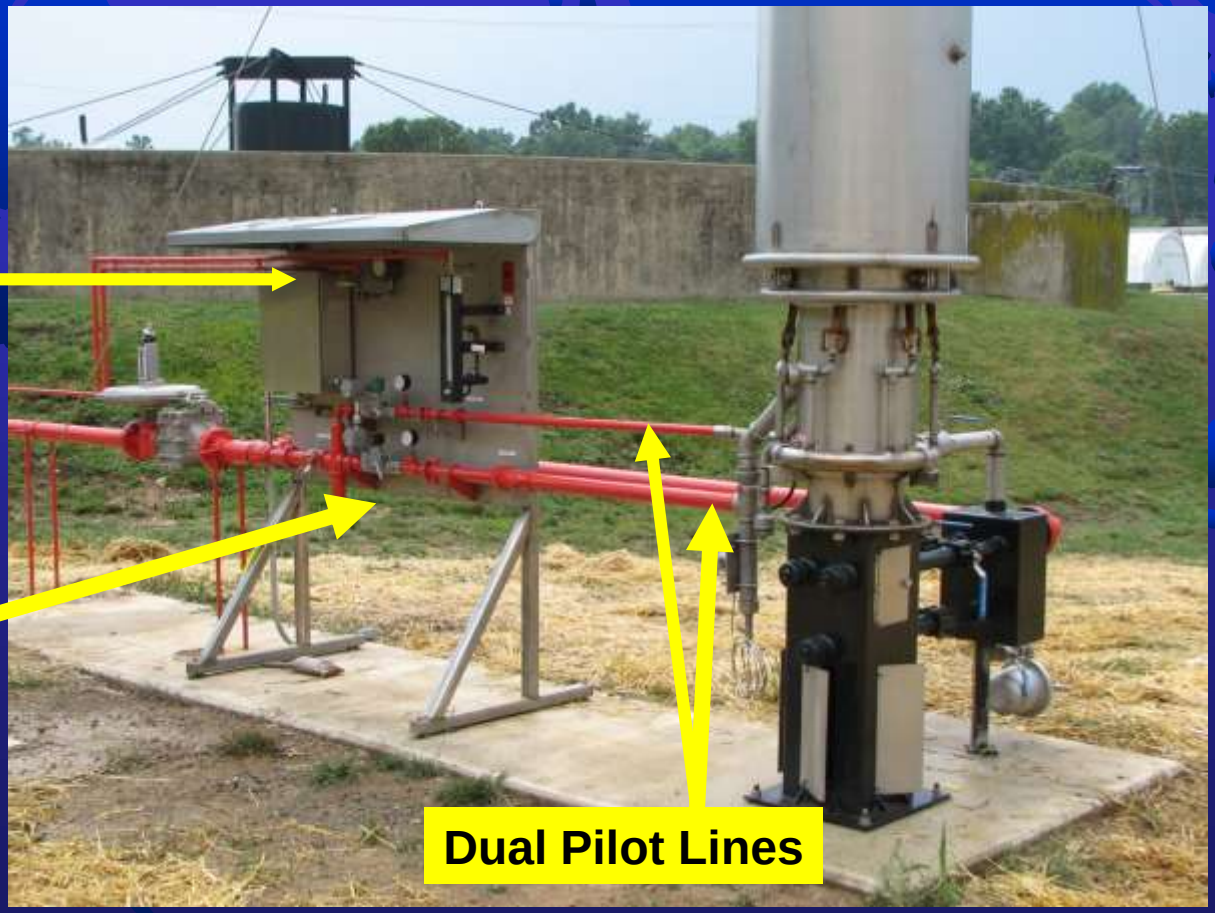
244E Enclosed Flare with Automatic Pilot Ignition System

Installation

Control Panel

Pilot Gas Valve and Regulator Panel with weatherhood and mounting stand



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Digester Cover Equipment

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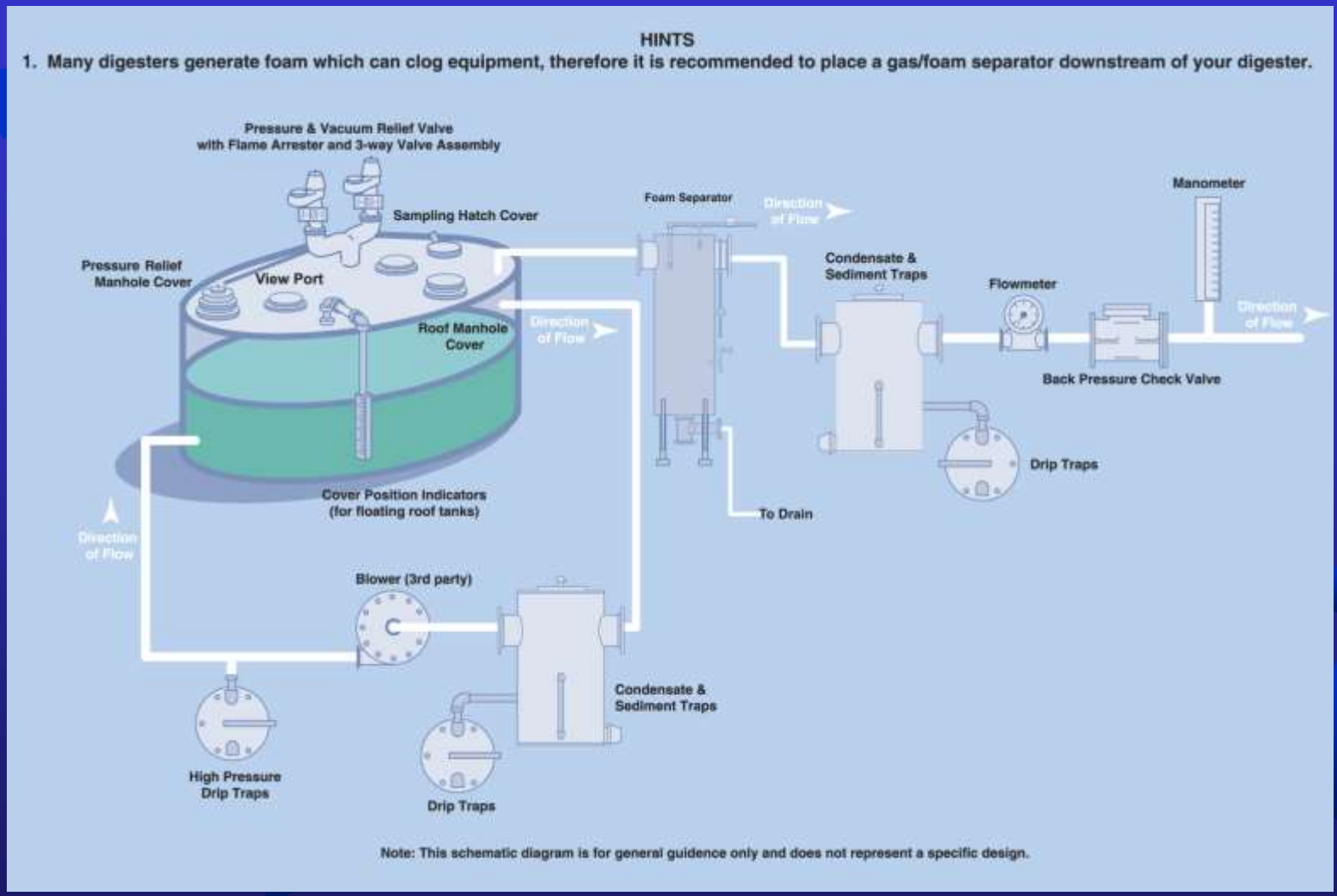
Biogas Systems



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5810B/5820B Relief Valve with Flame Arrester Assembly

1. Varec Model 5810B - Vent to Atmosphere
2. Model 5820B - Pipe Away
3. Model 5811B or 5821B -All-weather model

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5810B/5820B Relief Valve with Flame Arrester Assembly

Purpose

- PVR Valve - Protects Digester from overpressure and vacuum.
- Flame Arrester - Protects Digester from flame flashback from outside source.

Pipe-Away

Vent-to-Atmosphere

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2010B/2020B Series
Pressure & Vacuum Relief Valve

OPERATION

- Provide over pressure relief as well as Vacuum protection
- Field adjustable
- Dead weight loaded pallets
- Teflon inserts for seating surface
- Model 2011B/2021B – All weather version
  1. “All Weather” feature protects the valve in temperatures ranging from -25o F to +200 o F (-32 o C to + 93 o C).
  2. Includes special anti-freeze coating applied to seat ring tip, pallet periphery and stem, and guide posts.

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2010B/2020B Series
Pressure & Vacuum Relief Valve

Sizing and Setting Criteria

Pressure and Vacuum Setting

- Allowable over- pressure – 20% above set pressure. Minimum is 10%
- Allowable under-pressure – 50% above set pressure. Minimum is 10%

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2010B/2020B Series
Pressure & Vacuum Relief Valve

Installation

Calibration

1. Verify Setting - the actual weight of the pallet assembly (including loading weights). Adjust loading weights as required.
   Weight tolerance: + 5%/- 5%
   Setting tolerance: + 0%/- 10%

PALLET LOADING (INCLUDES WEIGHT OF PALLET)		
VALVE SIZE	OUNCES OF WEIGHT REQUIRED PER OUNCE OF SETTING	OUNCES OF WEIGHT REQUIRED PER INCH OF WC SETTING
2”	8.3	4.8
3”	16.8	9.7
4”	22.1	12.8
6”	43.4	25.1
8”	72.7	42.0
10”	120.1	69.4
12”	179.9	104.0

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2010B/2020B Series
Pressure & Vacuum Relief Valve

Maintenance

IMPORTANCE ON PROPER ROUTINE MAINTENANCE AND PREVENTATIVE MAINTENANCE

- Maintenance is key to operational performance.
- Leaking valves create odor problems, as well as harmful conditions.
- Leaking valves will adversely affect flame arrester operation.
- Improper handling can cause damage to pallets and seats.
- Simple maintenance can save an expensive Digester.

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5000/5010 Flame Arrester

Purpose:

- **Prevents propagation of flame or flame flashback.**

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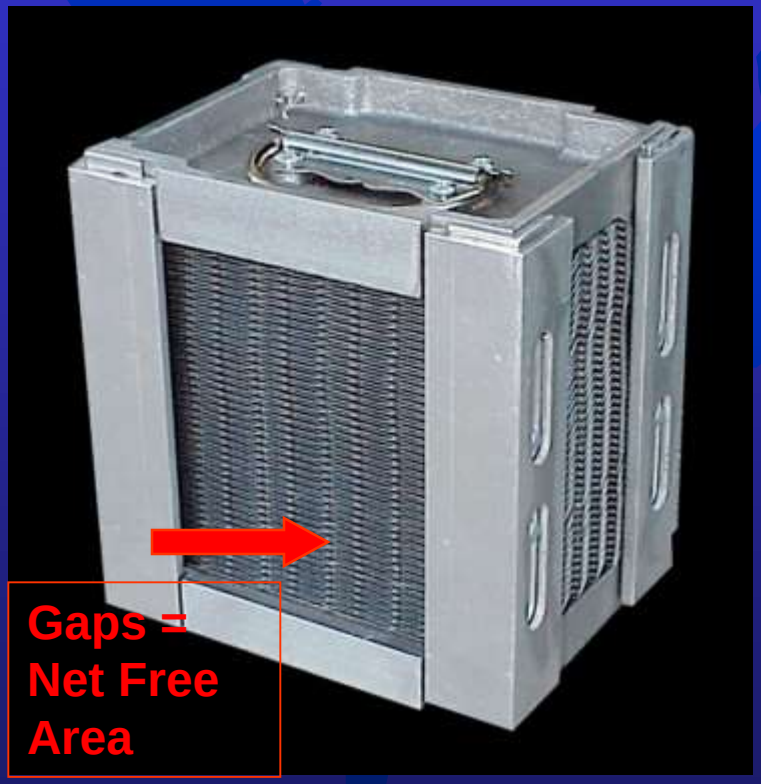
5000/5010 Flame Arrester

Operation



- Work as a heat sink.
- Dissipate heat through corrugated sheets as well as large surface area.
- Static, in-line device
  - Must inspect or undergo routine maintenance to determine if suitable for continued use.
- Prevent flame propagation in biogas headers.
- Protect Digesters from flash back.
- Install within 15’ from flame or Oxygen source.

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5000/5010 Flame Arrester

Features

- Cleaning Procedure:
  - Wash bank sheets with a mild solvent.
  - Rinse sheets with a solvent that does not leave an oily film. This is necessary to avoid collecting foreign matter.
  - Blow out dry particles with compressed air.
  - Wash bank sheets with hot water.
  - Steam bank assembly clean.
  - Can use spray washing for cleaning.

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5000/5010 Flame Arrester

IMPORTANT CONSIDERATIONS:

1. Have spare bank assembly – One per size and type.
2. Horizontal Flame Arresters (5010) –
   a. Can be installed on vertical or horizontal line.
   b. Check to make sure that the drain is at the 6 o'clock position.
2. Vertical Flame Arresters (5000)
3. Orient flame arrester so that there is access to the "Removable Cover".
4. Re-assembly
   a. Make sure the bank assembly is pushed all the way in.
   b. Tighten the bolts on the removable cover in a star cross pattern.
5. DO NOT MATE A FLAT FACE FLANGE TO A RAISED FACE FLANGE or use proper spacer.

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5000/5010 Flame Arrester

Preventative Maintenance

- Must be maintained because:
  - Can plug up from debris in gas.
  - Located in corrosive gas stream.
- Good Preventative Maintenance saves on equipment and man hours.

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5000/5010 Flame Arrester

Versus Round Configuration

Core assembly (sample)

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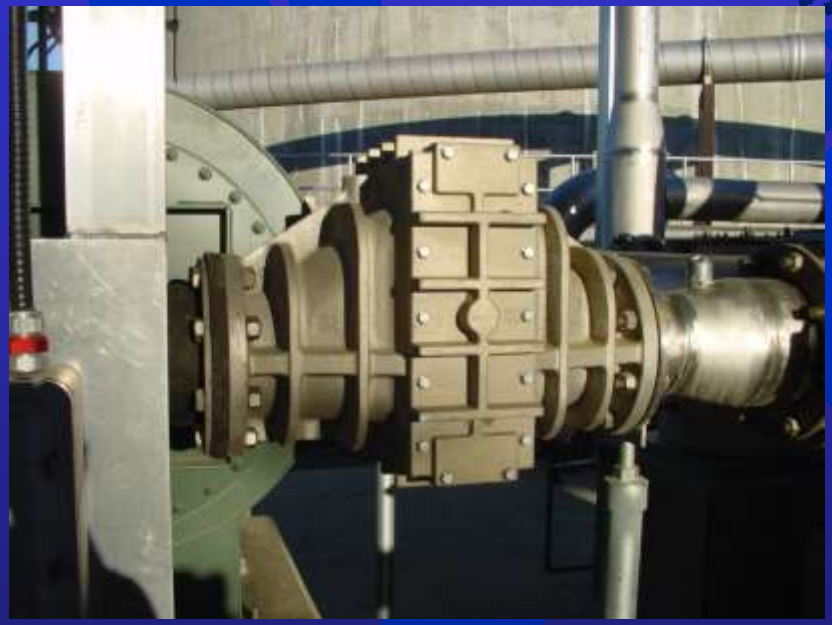
5000/5010 Flame Arrester

Versus Square configuration with Alternating Flat and Crimped Ribbon



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5000/5010 Flame Arrester

Alternating flat and crimped plates

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Pressure/Vacuum Relief Valve and Flame Arrester with Safety Selector Valve

Typical Installation

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Safety Selector Valve

- Allows for cleaning of one assembly while still protecting digester
- Unique operator design won't stick. Non-lubricating. Teflon seals.
- Easily operated without gears or actuators
- Full port and smooth flow path provides low pressure drop

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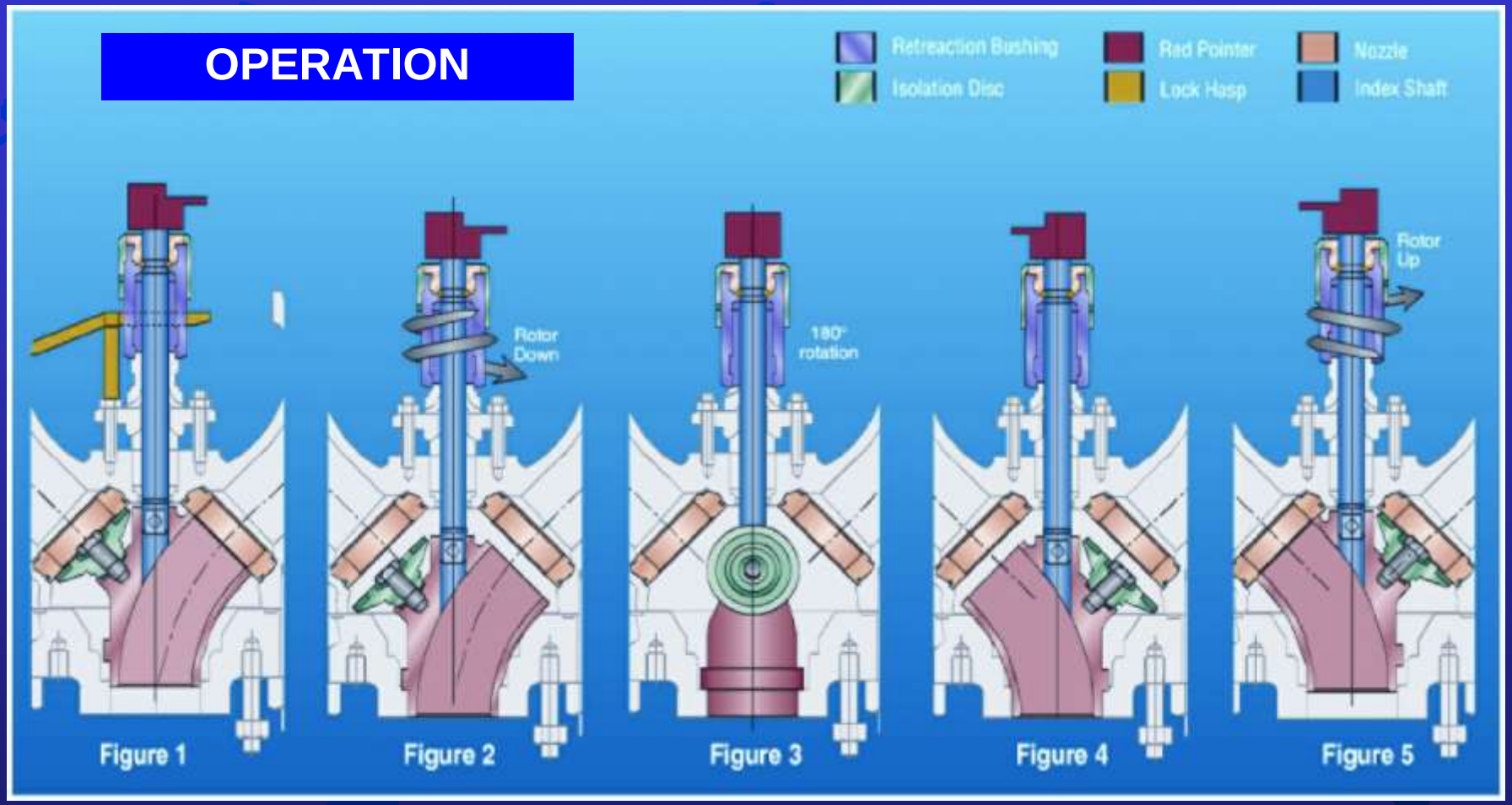
Safety Selector Valve



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220/220W Series Manhole Cover

Uses

- Light weight, quick-Opening and Gas-tight for easy digester access
- 1 psig (7 Kpa) Working Pressure Maximum
- Available sizes:

  18”, 20” 24”, 30”, 36”, 42”, 48”

220W

220

Varec BIOGAS

220VP Series View port Inspection Cover

USES

- Easy viewing access of vessel
- 23-3/4” actual viewing area
- Even Load Distribution Design
- Gas-Tight Seal
- Non-Sparking
- Stainless Steel construction
- Weatherhood for glass protection
- Cleaning rod and wiper assembly
- Maximum working pressure up to 1 psig (6.9 kPa)

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400W Emergency Pressure and/or Vacuum Relief Manhole Cover

Pressure and Vacuum

USES

- Provide Pressure and/or Vacuum Relief.
- Self-draining
- Hinged pivot design for reseating

Pressure

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400W Emergency Pressure/ Vacuum Relief Manways

Installation

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Sampling and Gauging Hatch Cover

42 Series

Purpose

- Provide quick access for sludge sampling and temperature measurement.

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2592 Series Cover Position Indicator

Purpose

- Measure the cover travel for floating roof Digesters
- Used on Gas Holders

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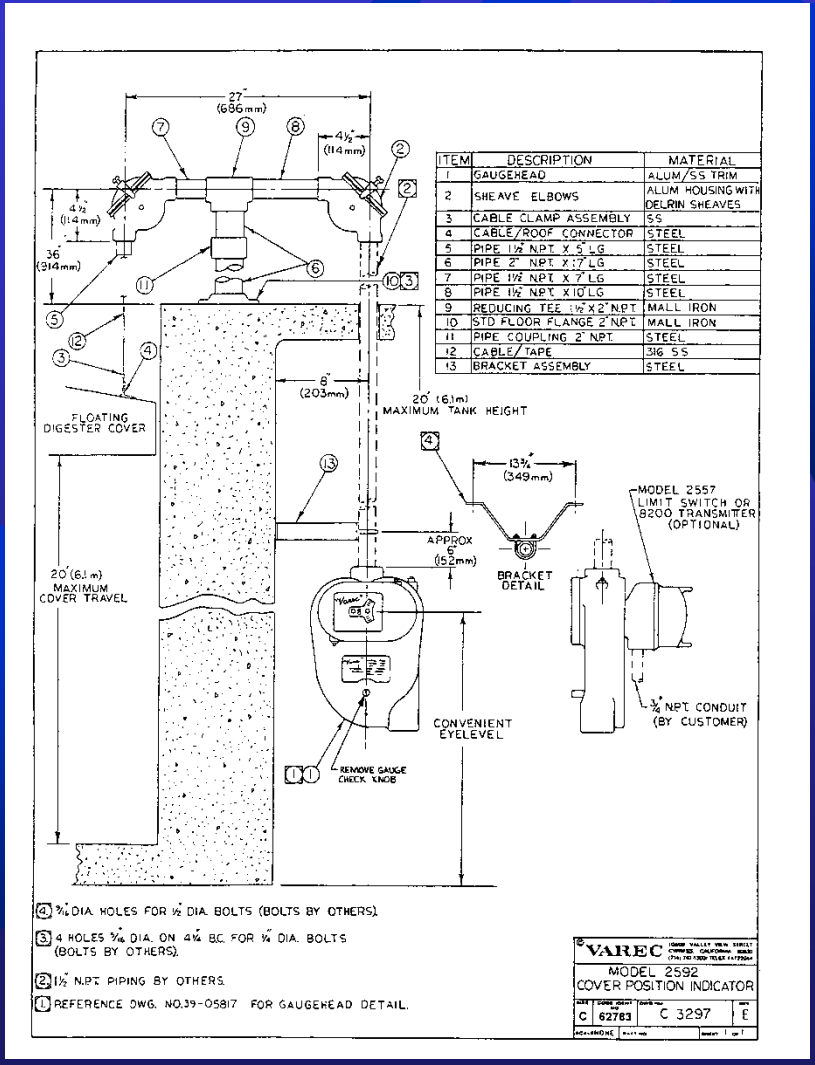
2592 Series Cover Position Indicator



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Biogas Systems – Digester Gas Take-Off Line

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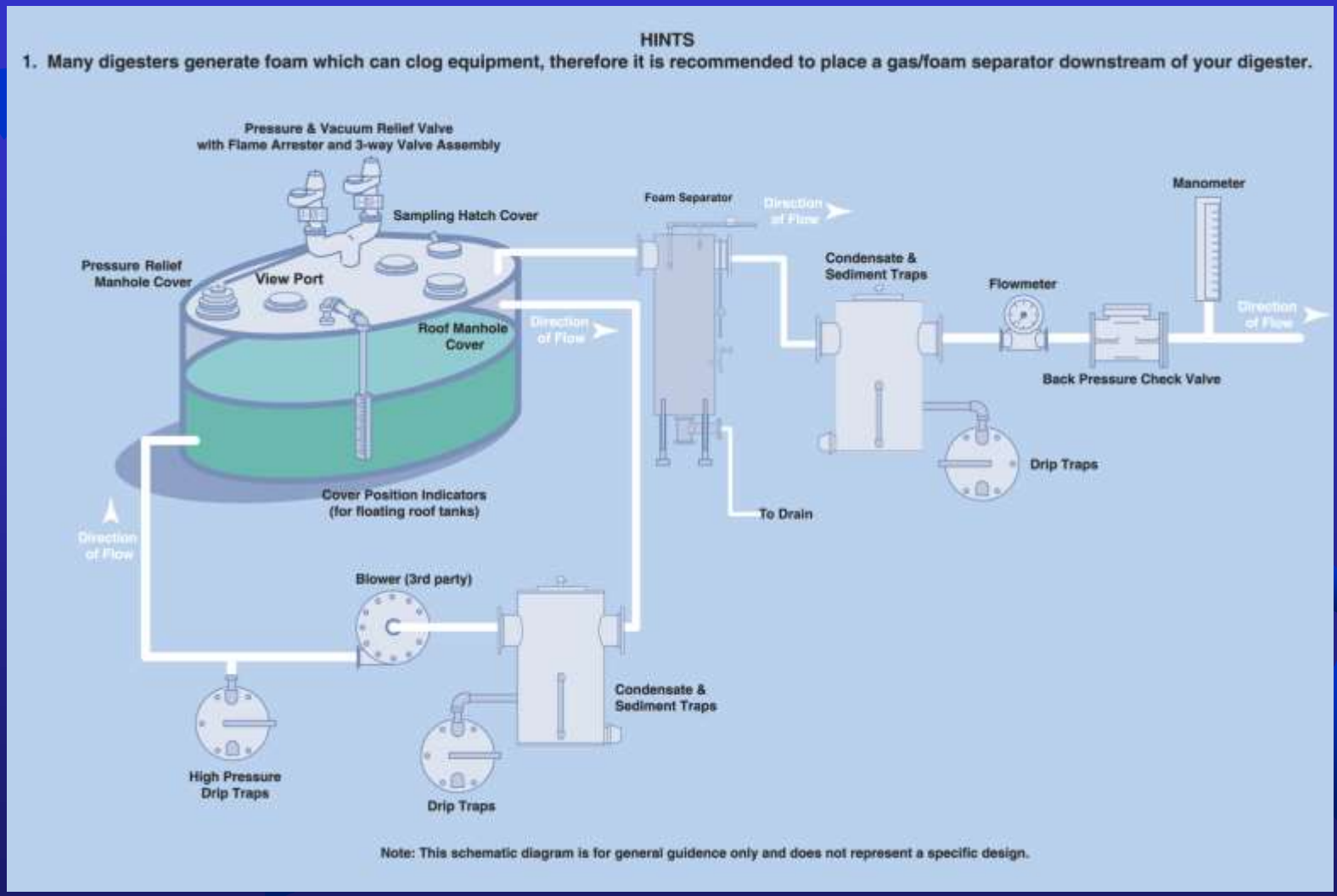
Biogas Systems



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231 Series Foam Separator

Uses

- Prevents Digester Generated Foam From Going Into the Gas Line.

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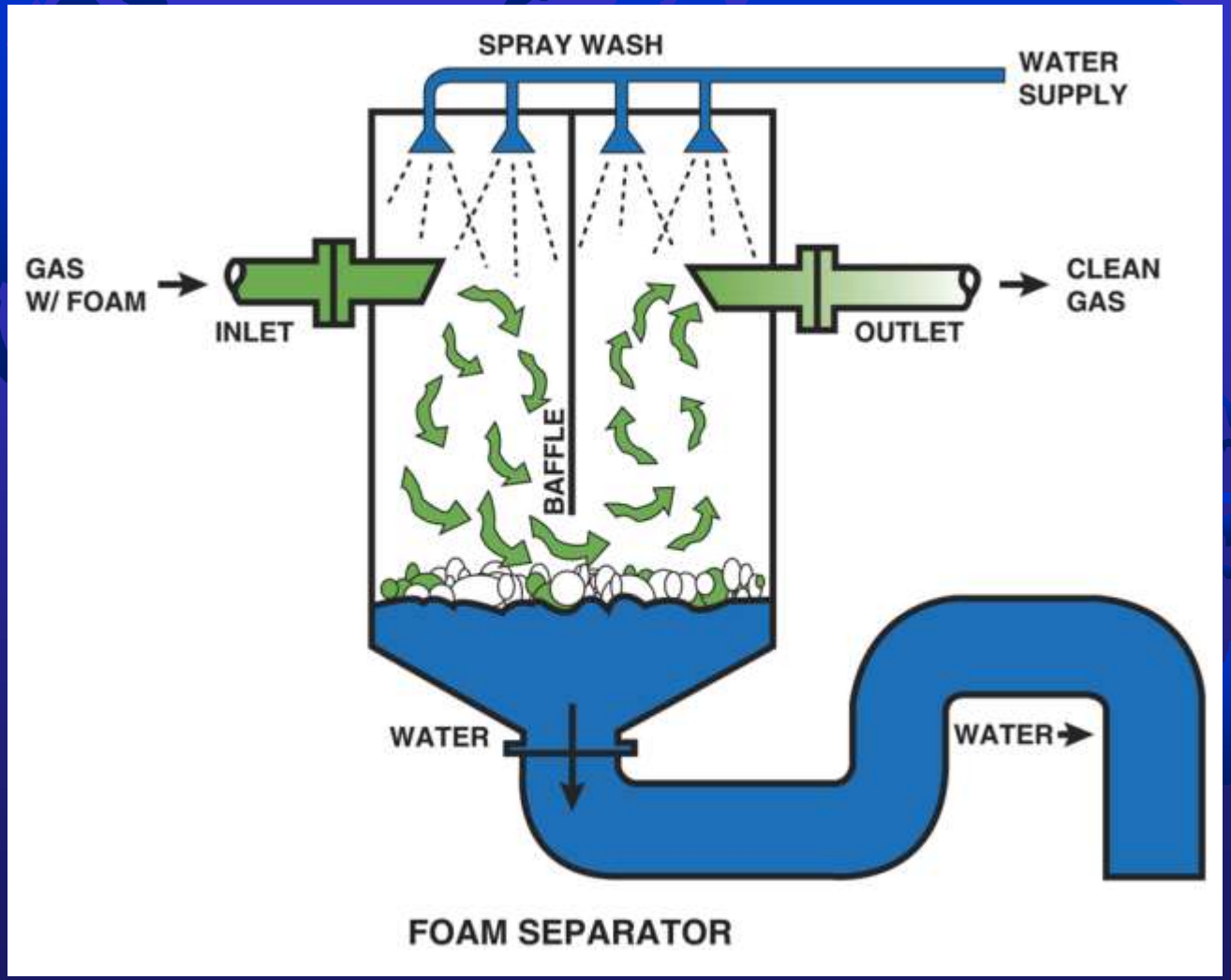
231 Series Foam Separator

Operation:



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231 Series Foam Separator

Installation

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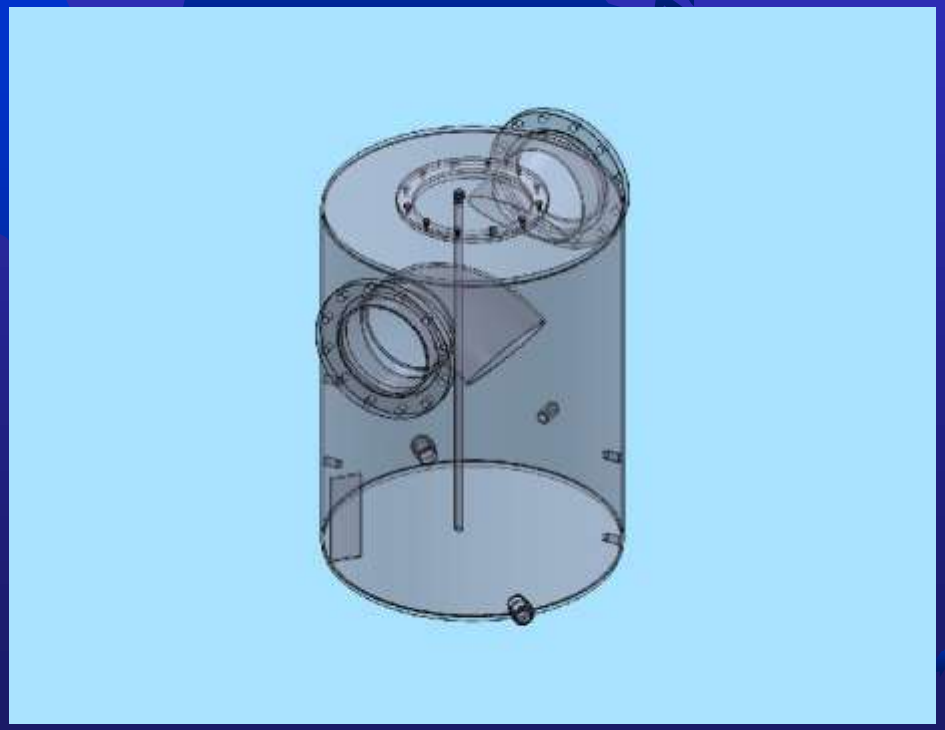
233 Series Condensate & Sediment Trap

Purpose:

- **Removes Liquids and Solids From Biogas Stream as biogas exits digester.**



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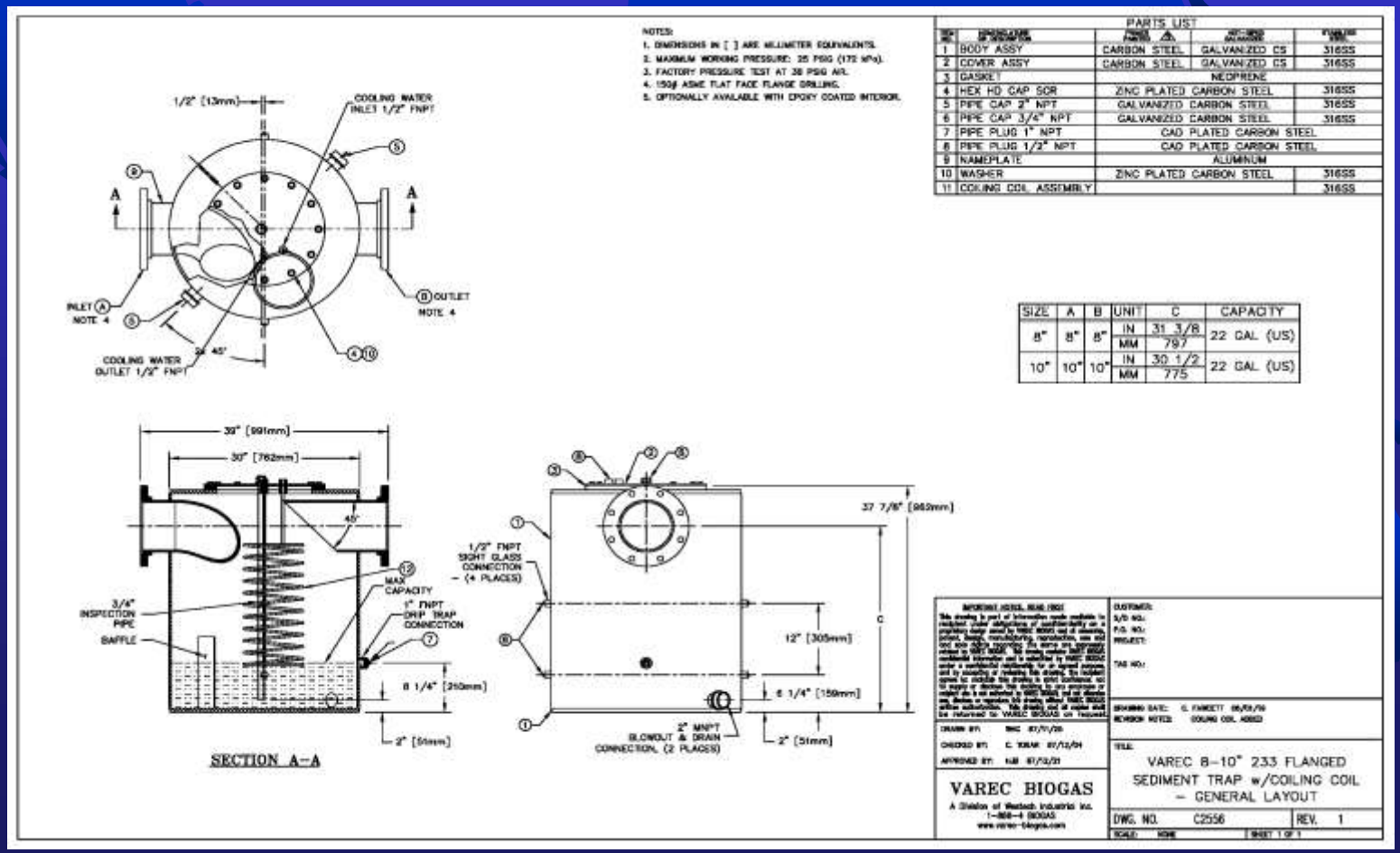
233 Series Condensate & Sediment Trap

Cooling Coil Option - To assist in additional condensate removal with the use of cooling water running through the coil.



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233 Series Condensate & Sediment Trap

Installation

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245 Series Automatic Drip Trap

Purpose

- Provides automatic drainage of liquid with the use of a float-operated needle valve.
- Maximum working pressure of 25 psig (173 kPa).

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245 Series Automatic Drip Trap

Rule

When can you use a 245?

1. **MOP 8 – permits float operated drip traps outdoors. If installed indoors, recommend installing gas detection units.**
2. **10-State Standard (IL, NY, IN, OH, IA, MI, PA, WI, Ontario Canada) – does not allow float operated drip traps.**

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245 Series Automatic Drip Trap

Installation

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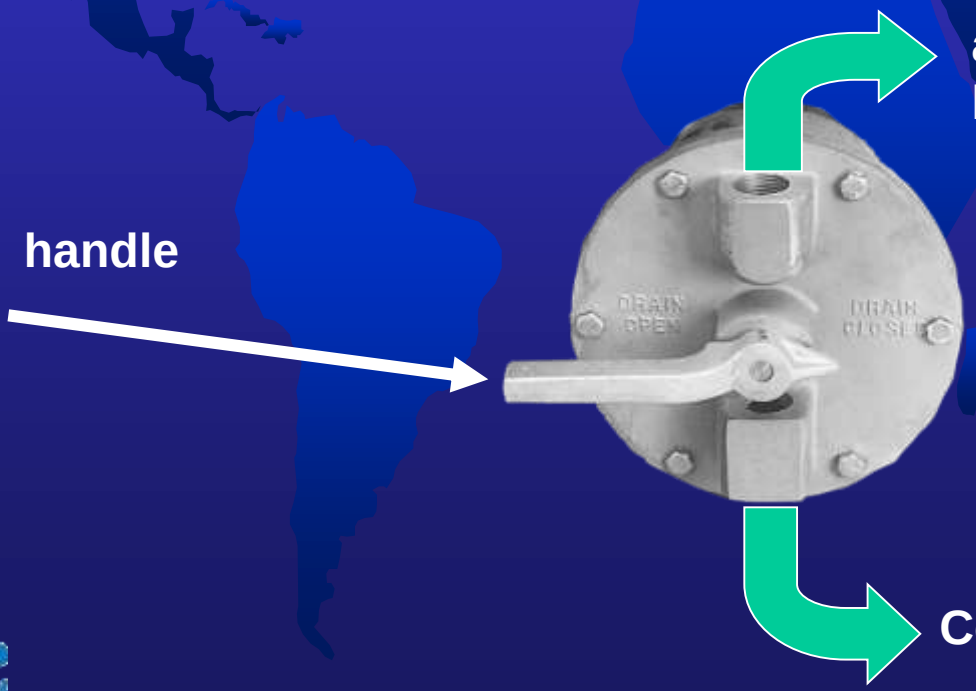
246 Series Low Pressure MANUAL Drip Trap

Operation

- Drain condensate without allowing gas to escape.
- Open and close handle to drain.



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246 Series Low Pressure Manual Drip Trap

Rule - When can you use a 246?

1. **Where the operating pressure is less than 5 psig.**
2. **Can be installed indoors and outdoors.**
3. **Indoor installation:**

   NFPA 820 requirement - 10 feet radius

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246 Series Low Pressure Manual Drip Trap

Rule - When can you use a 246?

4. Outdoor installation:

- the line be heat traced and insulated
- Sample Locations:
  1. Burner Header - Off ½" NPT Drain Connection of Flame arrester portion of Pressure Relief Regulator and Flame Trap Assembly.
  2. Gas Purifiers installed outdoors.

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246 Series Low Pressure MANUAL Drip Trap

Installation

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246AT Series Low Pressure Automatic Drip Trap

Purpose

- Automatically provides drainage of liquid in gas via electric actuation.

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246AT Series Low Pressure Automatic Drip Trap

Rule - When can you use a 246AT?

1. When the operating pressure is less than 5 psig
2. When the engineer wants automatic drainage and installation site is one of the States comprising 10-State Standard.
3. Same rules apply for indoor and outdoor installation as 246 Series. Indoor installation, actuator and timer in NEMA 7 enclosure is rated for Class 1, Divs. 1 and 2 so NFPA 820, 2008 edition is met.

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246AT Series Low Pressure Automatic Drip Trap

Installation

BIOGAS

247 Series High Pressure MANUAL Drip Trap

Operation

- Provides Drainage of Liquid Without Allowing Gas to Escape at operating pressures greater than 5 psig and maximum 100 psig.
- Body has two valves controlling FILL and DRAIN lines.
- Interlocking handle.

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247D Series High Pressure Low Profile Dual Chamber Drip Trap

Operation

- Provides Drainage of Liquid Without Allowing Gas to Escape at operating pressures greater than 5 psig and maximum 100 psig.
- Ideal for booster or compressor skids.
- Multi-stage compressors - condensate must be drained from two chambers with different pressures.

Varec BIOGAS

247 and 247D Series High Pressure Manual Drip Trap

Rule - When can you use a 247 or 247D ?

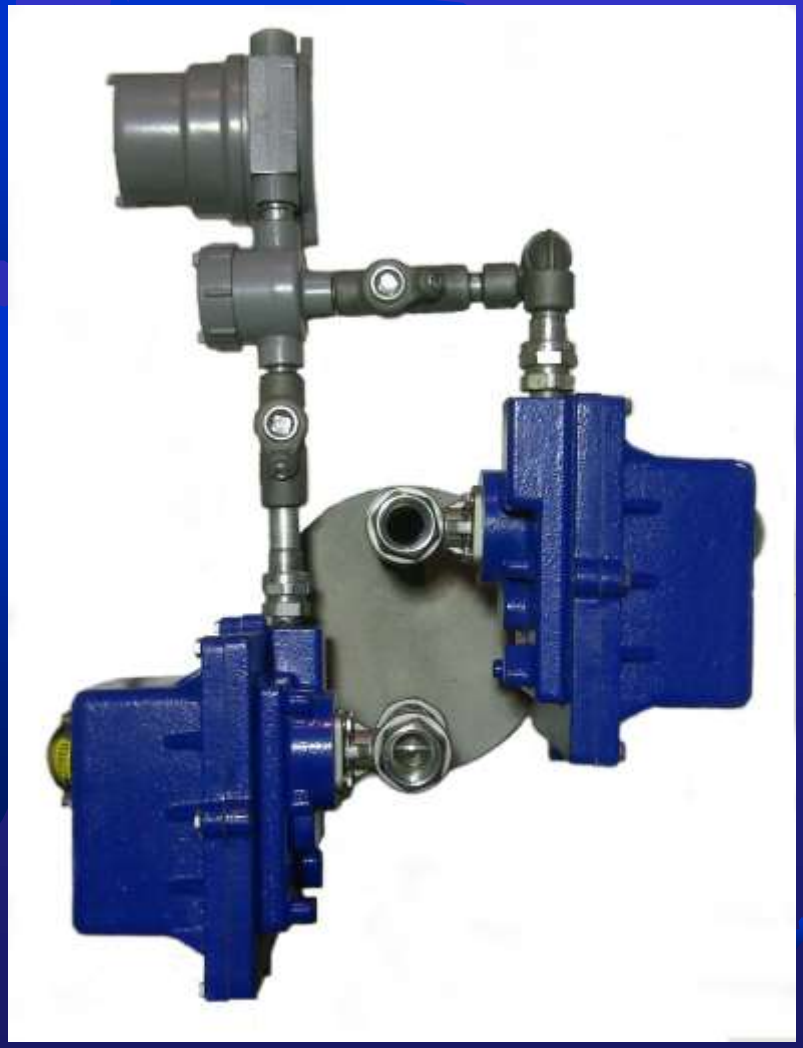
1. When the operating pressure is greater than 5 psig. Maximum rating is 100 psig (688 kPa).
2. Same rules apply for indoor and outdoor installation as 246 Series.

Varec BIOGAS

247AT Series High Pressure AUTOMATIC Drip Trap

Purpose

- Automatically provides drainage of liquid via interlocked electric actuation.



Varec BIOGAS

247AT Series High Pressure Automatic Drip Trap

Rule - When can you use a 247AT?

1. When the operating pressure is greater than 5 psig. Maximum rating is 100 psig (688 kPa).
2. When the engineer wants automatic drainage and installation site is one of the States comprising 10-State Standard.
3. Same rules apply for indoor and outdoor installation as 246 Series. Indoor installation, actuator and timer in NEMA 7 enclosure is rated for Class 1, Divs. 1 and 2 so NFPA 820, 2008 edition is met.

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246AT or 247AT Series Drip Trap
LOCAL CONTROL PANEL

- Can operate and monitor up to 5 maximum 246AT or 247AT

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Drip Trap Control Panels

Installation

- Automatic operation and monitoring
- Explosion proof applications
- Confined space usability
- Adjustable timers
- Remote operation
- Full display available

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246AT or 247AT Series Drip Trap
LOCAL CONTROL PANEL

Multiple Station

Inside lay-out

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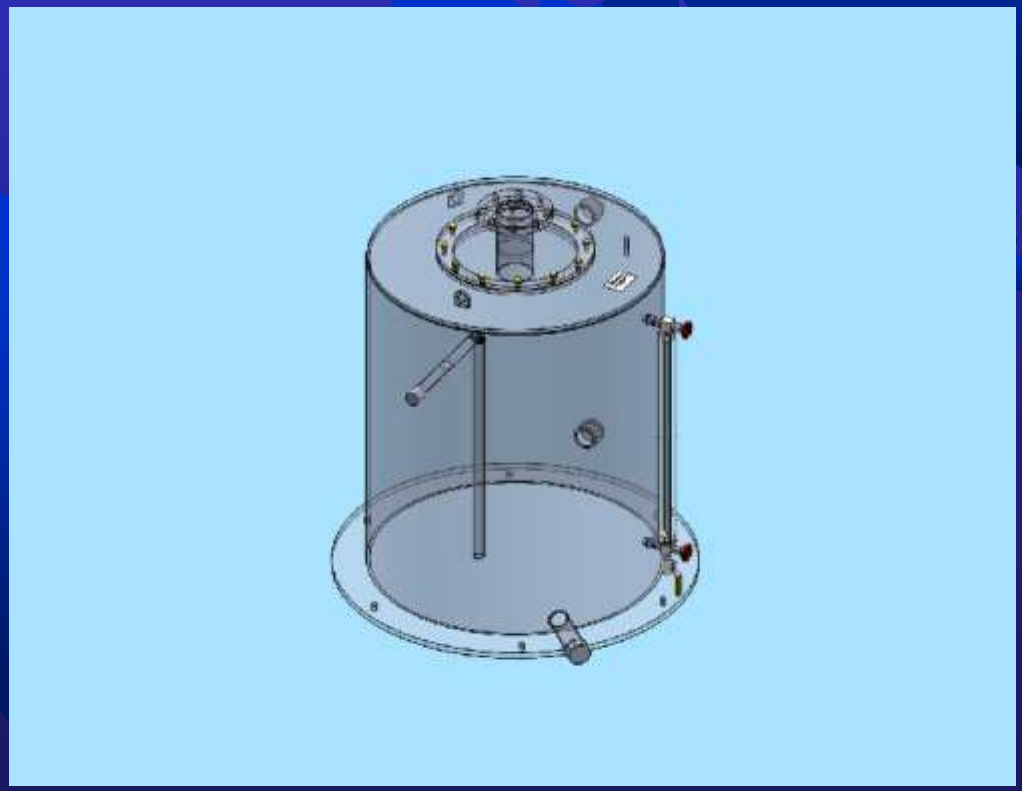
248 Series Condensate Accumulator

Purpose

- Stores large volumes of liquid condensed from Digester Gas
- Protects piping and equipment from possible damage due to corrosion.



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248 Series Condensate Accumulator

Installation

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211 Series Check Valve

Purpose

- Prevents Reversal of Flow

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211 Series Check Valve

Installation

- Follow flow direction on body when orienting in pipe.
- Don’t install on vertical run.

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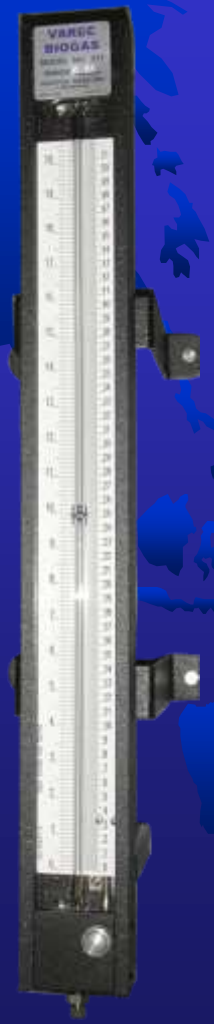
217 Series Manometers

Operation

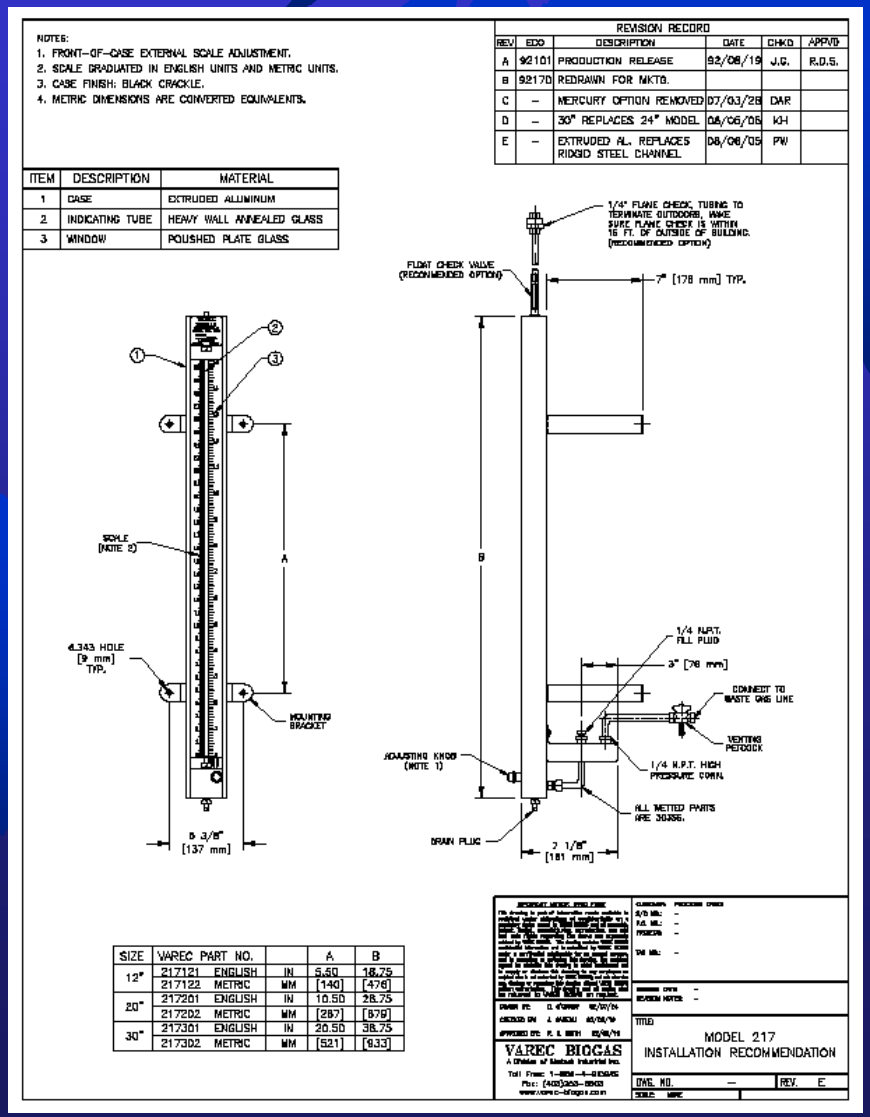
- Measure the Gas System Pressure by direct reading.
- As Pressure Rises, Fluid Rises in Graduated Tube



Varec BIOGAS

217 Series Manometers

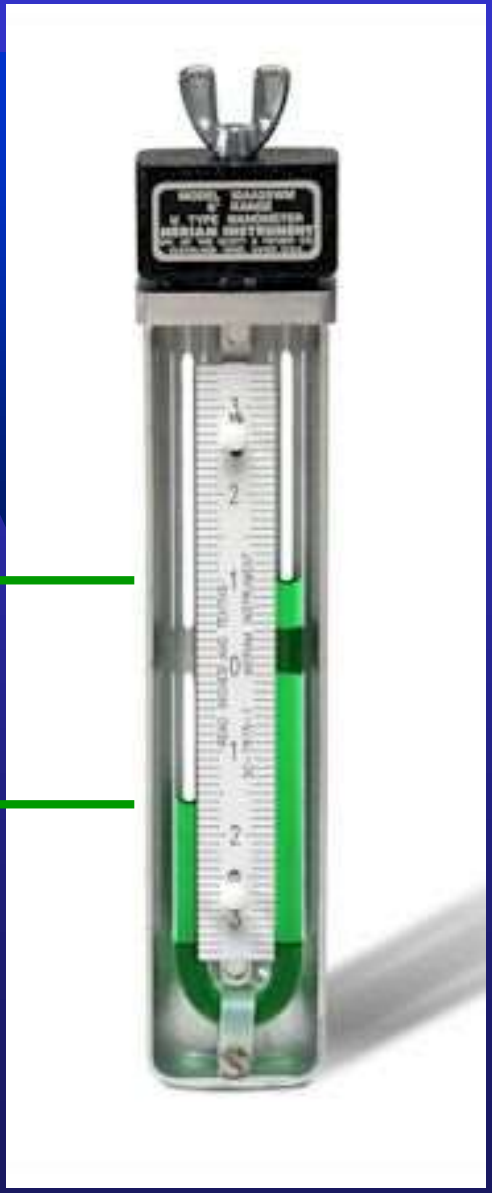
Installation



219 U-tube Series Manometers

Operation

- Measure the Gas System Pressure, vacuum or differential pressure reading.
- Height of the fluid is the pressure in the system.



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Gas Utilization Train

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7100B Series Pressure (Explosion) Relief Valve

Operation

- weight loaded pallet lifts upon rising pressure, relieving excess pressure to atmosphere.
- Installed on boiler/heat exchanger headers.

- ✓ **Relieves overpressure on line caused by flame flashback.**
- ✓ **Prevents explosion/detonation.**

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7100B Series Pressure (Explosion) Relief Valve

Installation

Terminate outside of a building off the main gas line. Should install with isolation valve.

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180 Series Double Port Regulator

Operation:

- Controls upstream (180/186) or downstream (181/187) pressure.
- Constantly throttling to maintain set pressure.

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180 Series Double Port Regulator

Installation

- Don’t install on vertical run.
- Sense line – 10 feet upstream or downstream of valve (minimum). If not, see next slide.
- Install so there is access to diaphragm and weights.

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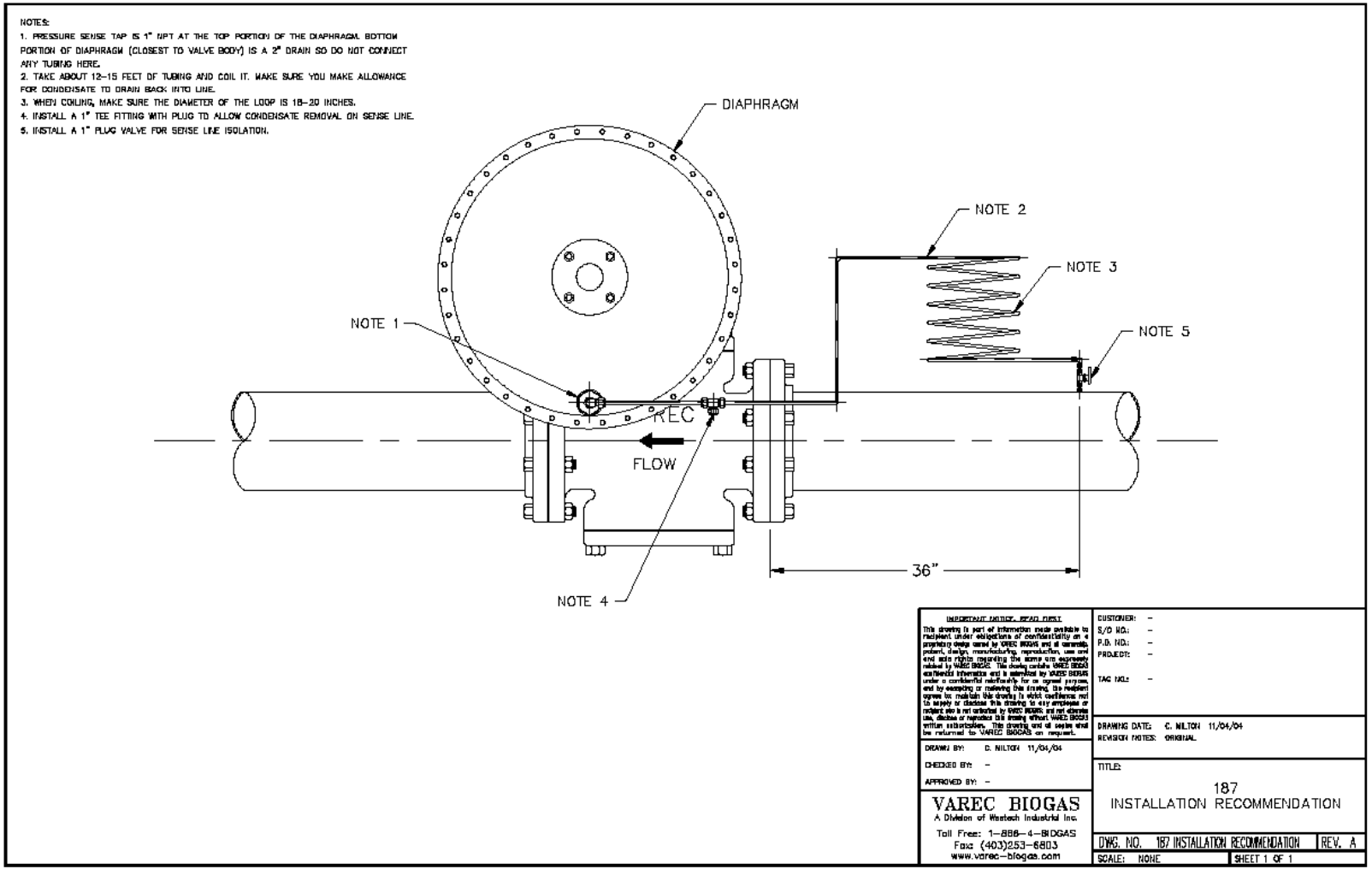
180 Series Double Port Regulator

Installation



Gas Conditioning System

Varec BIOGAS

Complete System

Biological H2S Removal

Iron Sponge H2S Removal

Siloxane Removal

Treated Gas

Control Valve

CHILLER

Coalescing Filter

Coalescing Filter

Compressor

Gas to Gas Heat Exchanger

Glycol to Gas Heat Exchanger

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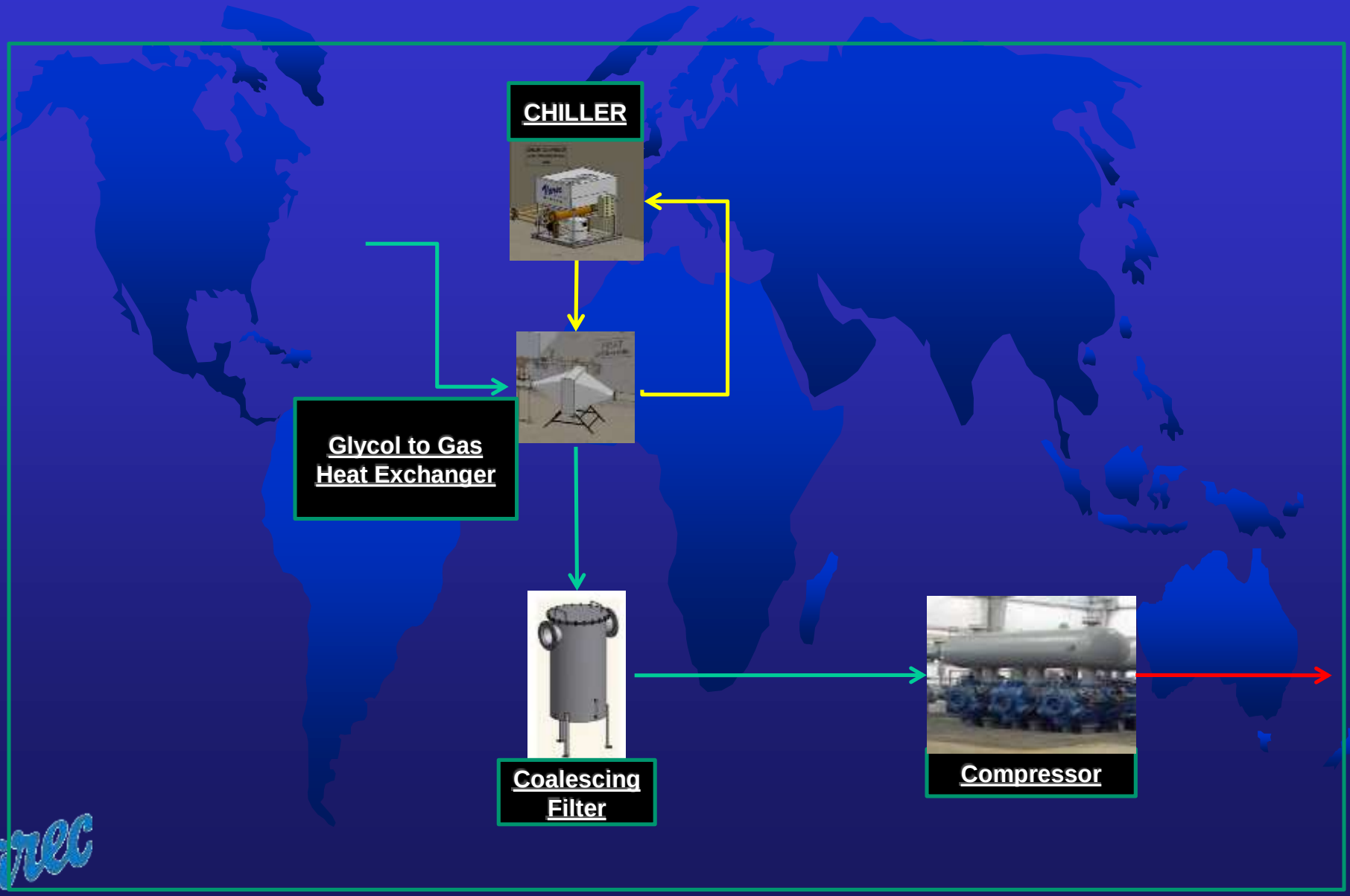
Moisture Removal and Compressor Only



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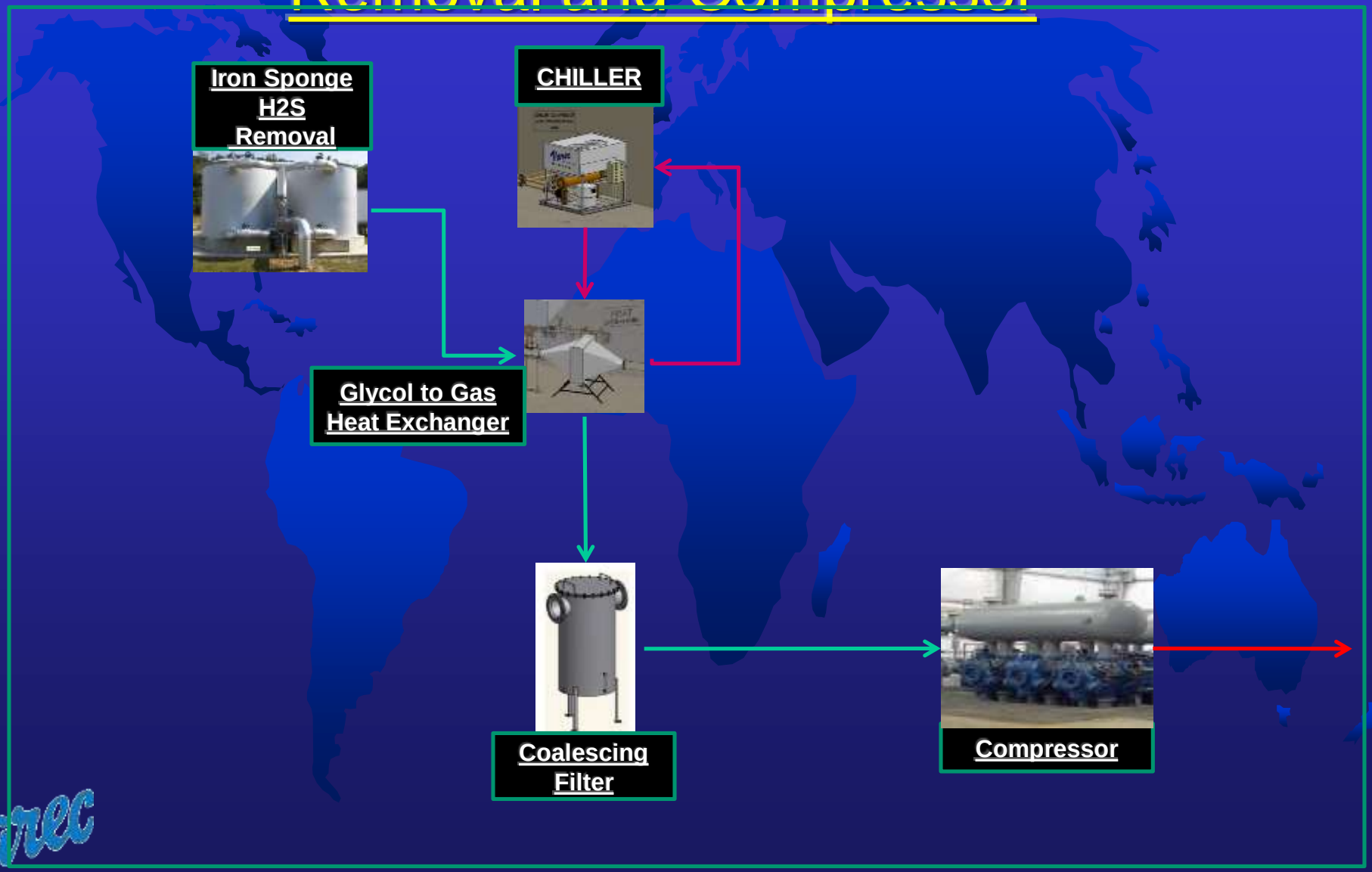
Moisture Removal with Iron Sponge H2S Removal and Compressor



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Moisture Removal with Biological H2S Removal and Compressor

Biological H2S Removal

CHILLER

Glycol to Gas Heat Exchanger

Coalescing Filter

Compressor

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Hydrogen Sulfide Removal – Iron Sponge Media

→ Model 235 Gas Purifier – Steel or SS construction

Model 236 Gas Purifier – Fiberglass construction

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Gas Purifier

Principle

H2S removal from biogas using iron sponge

$$2\ Fe_2O_3 + H_2O + 6H_2S = 2Fe_2S_3 + 7H_2O + heat$$

Iron sponge regenerated:

$$2Fe_2S_3 + 3O_2 = 2Fe_2O_3 + 6S + heat$$

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Gas Purifier

Sizing Criteria

Sizing dependent on the following parameters:

- Inlet Flow Rate
- Inlet and Outlet Pressure
- Inlet H2S Concentration
- Expected H2S outlet concentration

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Model 235 Gas Purifier

Epoxy Coated Carbon Steel or optional Stainless Steel

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Model 236 Gas Purifier

Model 236 Gas Purifier – Fiberglass construction

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Model 236 Purifier

FIBERGLASS CONSTRUCTION

- ✓ Lightweight
- ✓ High Grade
- ✓ Spark-Resistant
- ✓ NFPA 820 Fire Retardant

Corrosion Resistant

1. Factor of 4 or more compared to Epoxy Coated Steel
2. Hetron 992 – ASTM E84, Class 1Flame spread Rating of 25 or less

Cylindrical design

1. Allows for proper gas distribution
2. Avoid gas channeling
3. No. of vessels still depend on Inlet H2S concentration and flow rate, but:
   - ✓ Smaller footprint dimension
   - ✓ Maintain cost effectiveness

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Model 235/236 – Continuous Regeneration Kit

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Media Removal System

Installation

- Nets are properly labeled. “TOP”, MIDDLE (if applicable) and BOTTOM.
- Drape straps on vessel side.

- Separate iron sponge from vessel wall

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Media Removal System

Removal

- Lift strap vertically upward.
- Repeat each step for remaining MIDDLE and BOTTOM straps.

- Lay spent iron sponge on ground in cloth.
- Pull straps off the side for re-use.
- Use vacuum truck to remove residual iron sponge off vessel.

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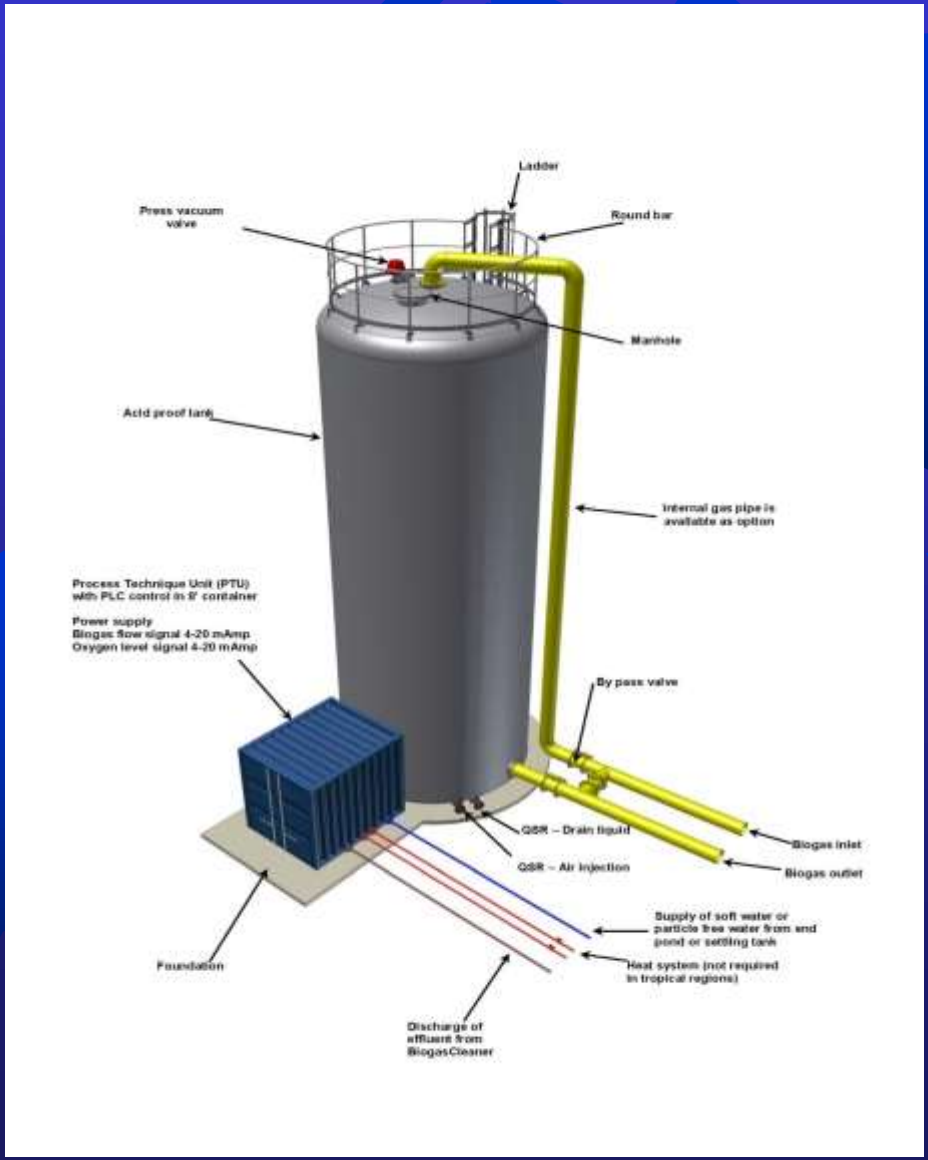
Hydrogen Sulfide Removal – Biological Media



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Model 237 Gas Chilling and Drying System

Coalescing Filter removes liquids and particulates

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Model 237 Gas Chilling and Drying System

Chiller and Heat Exchanger drop dew point of the gas

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Model 237 Gas Chilling and Drying System

Chiller drop dew point of the gas

Compressor heats gas providing dew point barrier

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