Lease Automatic Custody Transfer

ANGUS Measurement Services, LP

Leaders in Flow Measurement

Angus Manufactured LACT Units

Leaders in Flow Measurement

LACT Unit Requirements

- Are used for the automatic unattended measurement of crude oil.
  - Accurately measure the quantity of liquid transferred while monitoring the crude oil quality
  - Prevent the transfer of non-merchantable oil.
  - Obtain a representative sample of the process fluid
  - Can be used on land or offshore delivering product into pipelines, barges, or tanker loading and offloading operations.
- LACT units can range from low volume, low pressure, single meter installations with portable proving connections to high-pressure systems high volume systems with multiple meters and on-site dedicated proving systems.

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Control Functions of a LACT unit

- Detects level in the lease tank and starts and stops the pump which forces oil through the LACT unit
- Shuts down flow if rate is out of the desired range for accurate meter operation
- Shuts down flow once the maximum allowable oil has been transferred
- Operates the solenoid which extracts a sample proportional to flow
- Diverts flow back to the tank when S&W content is too high
- Actuate alarms as required

Components of a LACT unit

- Charge/Transfer Pump
- Strainer/Air Eliminator
- BS&W Probe and Monitor
- Static Mixer
- Divert Valve
- Sample System
  - Sample Probe
  - Volume Regulator
  - Sample Pot
- Sample System Interface
- Flow Meter
- Meter Prover Loop
- Back Pressure Valve
- Check Valve
- Isolation valves
- Control Panel`

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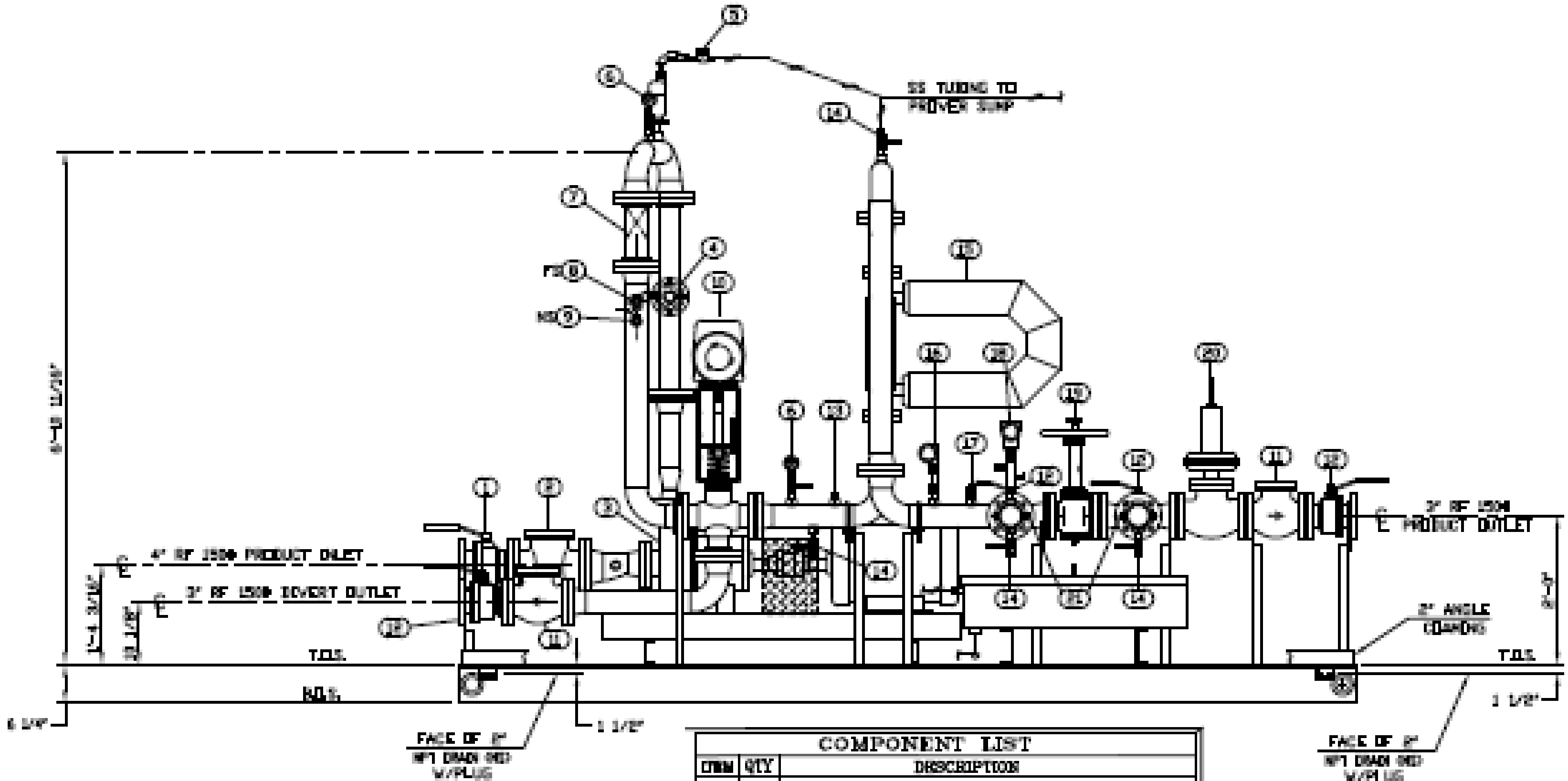
LACT - Typical Angus Configuration



COMPONENT LIST		
ITEM	QTY	DESCRIPTION
1	1	BALL VALVE, 4" RF 150#
2	1	STRAINER, 4" FF 125#
3	1	PUMP, 3X2X10
4	1	BS&W PROBE, 3" RF 150# W/4528 DETECTOR CARD
5	1	AIR RELEASE HEAD, ARMSTRONG MODEL 11AV, 3/4" X 1/2"
		WITH 1/4" NPT CHECK VALVE & 1/4" NPT BALL VALVE
6	2	PRES. GAUGE, 1/4" NPT, 2 1/2" FACE, 0-200 PSIG
		WITH 1/2" NPT BALL VALVE
7	1	STATIC MIXER, 3" RF 150#
8	1	AUTO SAMPLE PROBE WITH 1/4" NPT BALL VALVE,
		1/4" NPT SOLENOID VALVE & VOLUME REGULATOR
9	1	MANUAL SAMPLE PROBE WITH 1/4" NPT BALL VALVE
10	1	DIVERT VALVE, 3" RF 150#
11	2	CHECK VALVE, 3" RF 150#
12	4	BALL VALVE, 3" RF 150#

COMPONENT LIST		
ITEM	QTY	DESCRIPTION
14	4	BALL VALVE, 1/2" NPT
15	1	METER, CORIOLIS ELITE, 2" RF 150# W/TRANSMITTER
16	1	TEMPERATURE TRANSMITTER, 3/4" NPT
17	1	TEST THERMOWELL, 1/2" NPT
18	1	NEEDLE VALVE, 1/2" W/PRESSURE PIT
19	1	DOUBLE BLOCK & BLEED VALVE, 3" RF 150#
20	1	BACK PRES. CONTROL VALVE, 3" RF 150#
21	2	CAMLOCK, 3" QUICK DISCONNECT WITH DUST CAP
22	1	AMS STD SUMP WITH (2) 1" NPT BALL AND CHECK VALVE
23	1	AMS STD 15 GALLON SAMPLE SYSTEM
24	1	J-BOX, SEE DETAIL
25	1	PANEL RACK, SEE DETAIL

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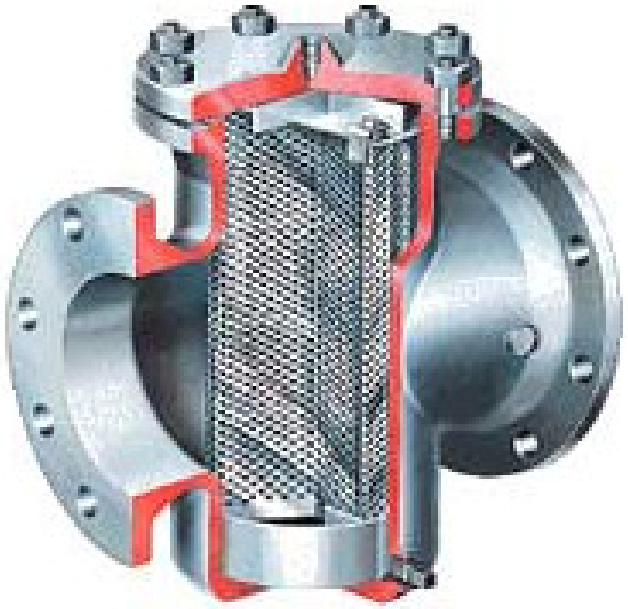
LACT Units - Charge/Transfer Pump

- The charge pump and motor are the primary energy source for the entire system.
- Flow rate, pressure required and fluid properties determine the size of the pump and motor.
- The charge pump and motor should produce a non-pulsating flow for the LACT unit at a pressure and flow rate compatible with the pipeline carrier
- Centrifugal pumps are typically used for LACT units requiring medium to high volumes at low pressure.
  - If high discharge pressure is required, a Centrifugal or positive displacement pump can be added at the LACT discharge to act as a booster pump to move fluid into the pipeline, thus enabling the base LACT a to remain lower pressure system, which can significantly reduce cost.

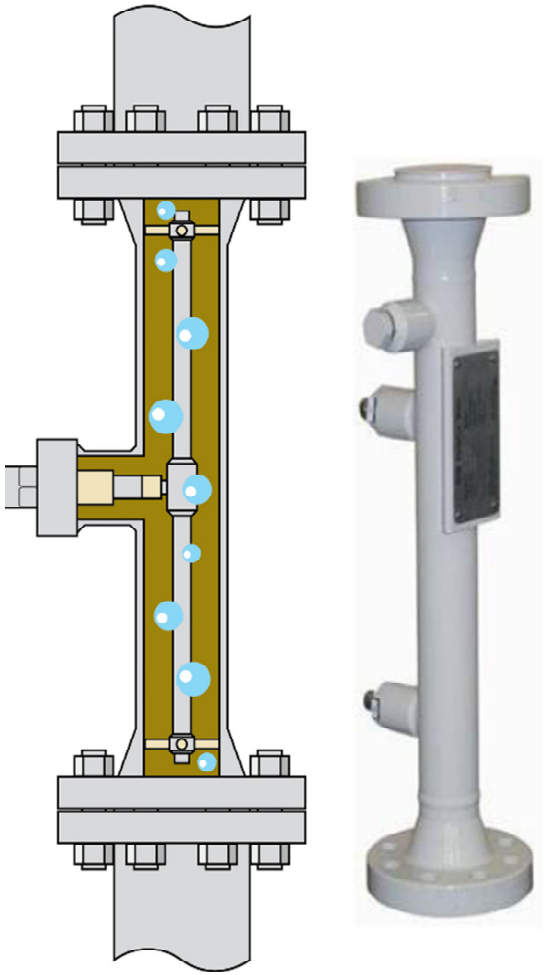
LACT Units - Strainer

- The strainer is an inline device which houses a removable perforated basket that is designed to collect solid materials
- Strainers are typically installed upstream of any measurement components to protect the entire LACT system, including the prover, from damaged by foreign materials
- The strainer basket will trap and collect all material that is larger than the perforations in the basket's screen.



LACT Units – S&W Probe

- S&W Probe
  - S & W probes determine free water and sediment content in crude oil by typically measuring the dielectric constant which is the ability of the fluid to act as an insulator.
  - The dielectric constant of oil is higher than that of water.

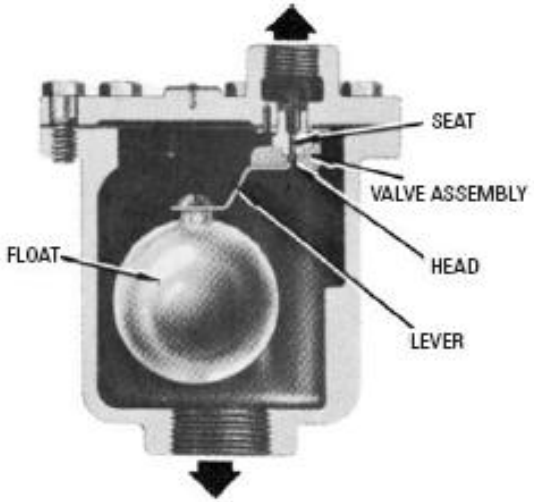


LACT Units - S&W Monitor

- BS&W Monitor is electronic device that detects changes in the dielectric constant with sensitivity that can detect 0.1% of 1%S&W content.
  - An indicator is provided on some units to display the amount of BS&W in the flowing
- The ability of this system to accurately signal the LACT Unit on excess BS&W content insures that only merchantable oil is delivered to the pipeline.
- An adjustable time delay and fail-safe relays operate the divert valve over a selectable setting of 0-3% S&W. If the S&W content exceeds a preset value (usually 1% on pipeline and 2% on truck) it signals an alarm and either shuts down the LACT unit or causes a divert valve to stop flow to the meter and diverts the off-spec oil back to a holding tank.

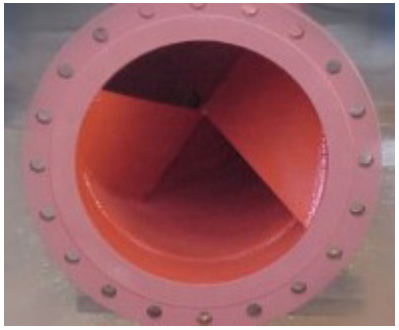
LACT Units - Air Eliminator

- An air eliminator is a device that is installed downstream of the charge pump, located at the highest part of the system to allow entrained air or vapor from the liquid stream to be discharged and not metered.
- Air eliminators operate using a float that is mechanically attached to an exhaust valve. The float is designed to float in the fluid and not in the air. As air or vapor accumulates in the top of the air eliminator, the liquid level is forced down until the float drops and the air is discharged through the exhaust valve to an atmosphere sump or drain.



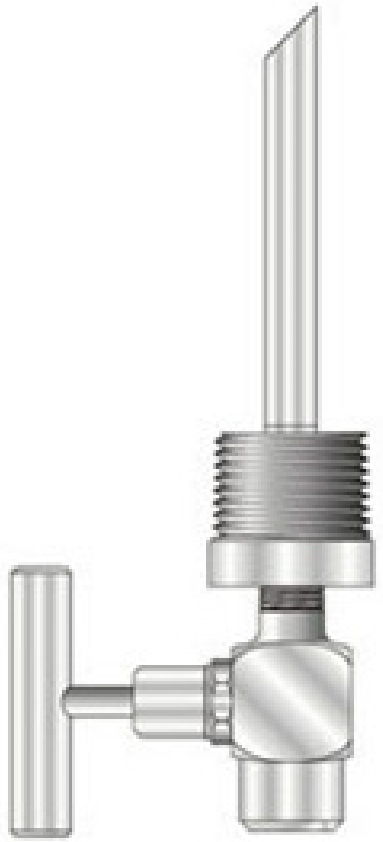
LACT Units - Static Mixer

- Static mixers (aka motionless mixers) are used in continuous processes where they homogenize fluids with no moving parts.
- The LACT charge pump moves the fluid to be mixed at the desired volumetric flow rates and also supplies the energy required for mixing. Rigid elements split, rearrange, and recombine component streams into smaller and smaller layers until one homogeneous stream exits.
- The static mixer is installed immediately upstream of the sampler probe. This assures that the liquid stream passing the sample probe is uniform and that each sample is representative of the bulk liquid stream.
- A minimum linear velocity of 3 feet per second is required for proper static mixer operation.



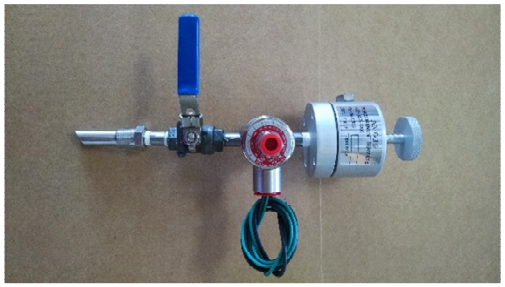
LACT Units - Sample Probe

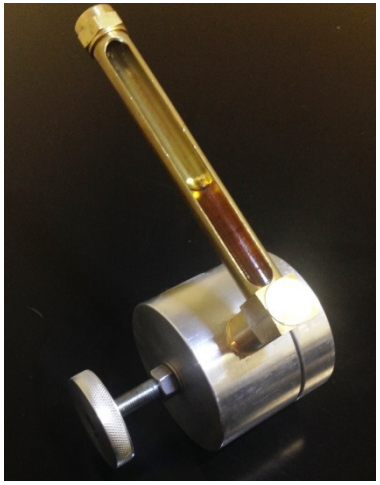
- The sample probe is used to retrieve a representative sample of the flowing stream.
- The sample probe is a small pipe or piece of tubing inserted horizontally through the LACT pipe wall. It is located in the center of the pipe with a 45 degree beveled tip, facing the flow from the static mixer.
- The outlet of the sampler probe is connected to a three-way electric operated solenoid valve. The solenoid valve is also connected to the sample container and to a "volume regulator".



LACT Units - Volume Regulator

- Is an adjustable, diaphragm type, positive displacement sample regulating device that is designed to collect a precise amount of fluid each time a solenoid valve is actuated.
- The outlet of the sample probe is connected to a three-way electric operated solenoid valve. The solenoid valve is also connected to the sample container and to the volume regulator.
- When the LACT Unit is in operation and the sample solenoid is electrically actuated or "energized", the sample probe is connected to the volume regulator and fluid under line pressure is allowed to fill the volume regulator and compress the spring load assembly. As soon as the sampler solenoid is de-energized, the trapped fluid, under pressure, in the volume regulator is injected into the sample container using both the fluid trapped pressure and the spring load assistance of the volume regulator.





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LACT Units - Sample Receiver

- The sample container is sized to allow adequate storage during the total transfer period.
- The fluid is stored under pressure and the container is vapor tight to prevent evaporation.
- The fluid is tested at the end of the period to determine the quality for custody transfer/net volume calculations.

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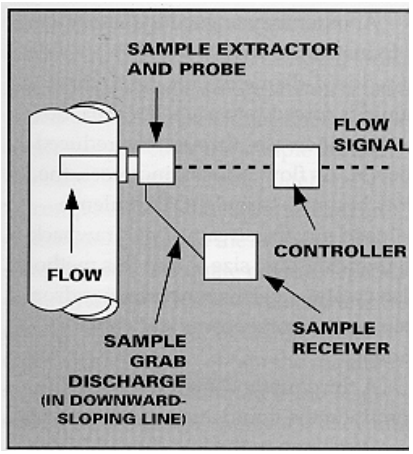
LACT Units - Sample System

- The components which make up a typical system include:
  - Static mixer
  - Sample probe
  - Extraction device
  - Sample Receiver/Mixer



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LACT Units - Divert Valve

- The divert valve is a three-way, two-position valve that is installed upstream of the meter and used to divert flow whenever a fault condition is detected.
- The divert valve is equipped with either an electric, hydraulic or pneumatic actuator that is connected to an internal shaft or plug that controls the flow path of the valve.
- The primary function to fail closed when any of the following occurs:
  - Excess S&W
  - Loss of power
  - Loss of supply pressure
  - Low level in the lease tank
  - Meter failure condition

LACT Units – Coriolis Meters

- The flow meter is used to accurately and precisely measure the total fluid stream and to accumulate the total LACT throughput.
- The Coriolis meters have no mechanical moving parts. The transmitter receives a frequency from meter.
- Multi-variable Measurement with no moving parts. It measures:
  - Mass, Volume, Density, Temperature
- Transmitter has a resettable and non-resettable totalizer, and also does the average temperature calculations, eliminating the need for a separate temperature averager

- **Reduces cost of ownership**
- **Displays mechanical meters**

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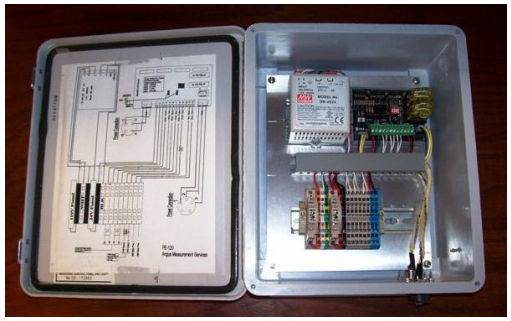
LACT Units - The LACT Controller

- The LACT Controller provides:
  - Local totalization
  - High speed pulse output for proving - 10,000 pulses per barrel
  - Four and five pin prover connections for onsite proving with 10K pulse output
  - Two scalable pulse outputs, one dry contact and one 24VDC pulse output, for remote monitoring and pacing of the sample system. It provides a pulse per barrel for your sampler and meter failure time
    - 11-30 VDC or 100-240VAC power supply



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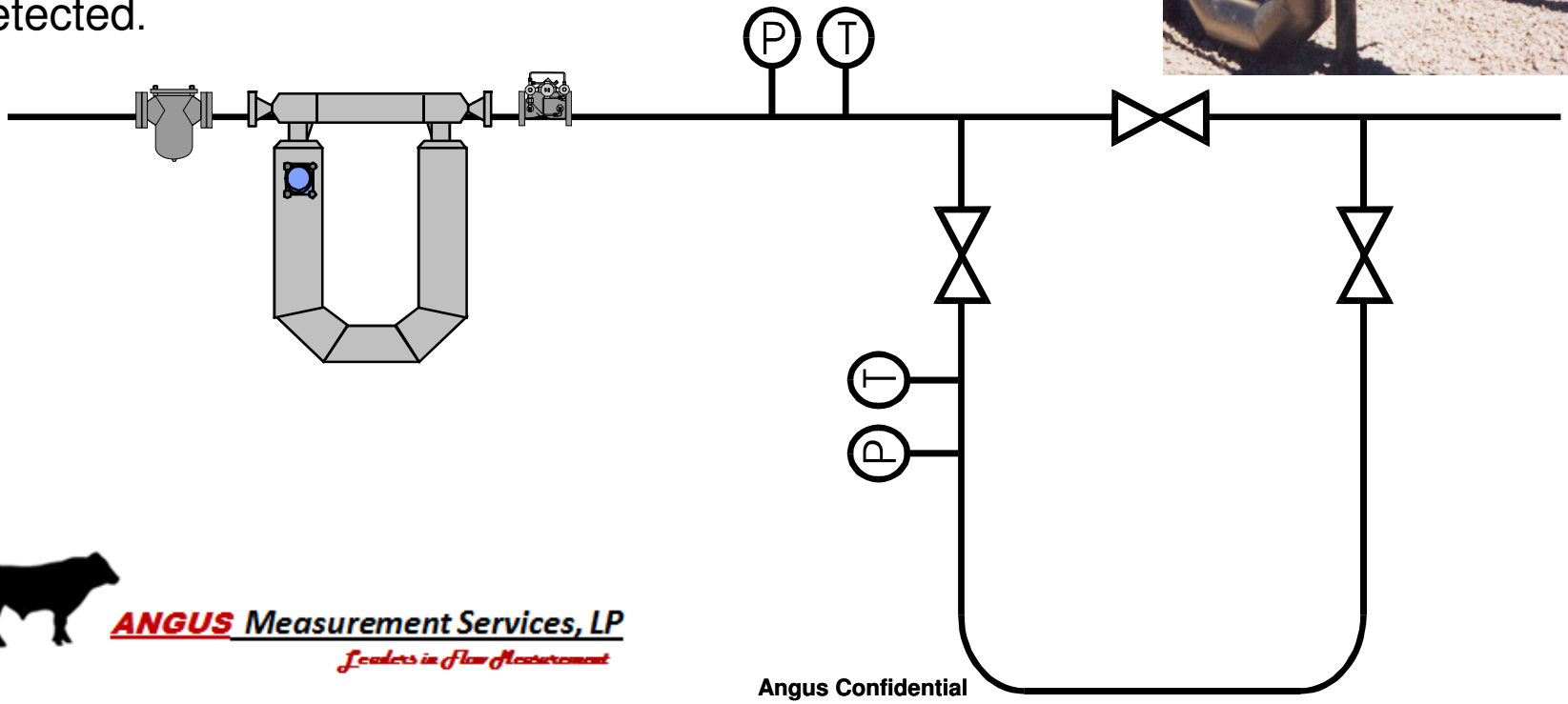
LACT Units

- Temperature Averager
  - Temperature averagers provide a true average of the process temperature based on volume or time.
  - Average temperature is utilized for calculation of net volume during a batch cycle, such as the end of the month.

MT-150
Single Channel Temperature Averager

LACT Units - Meter Proving Loop

The meter prover loop is a manifold using three valves connected to two tees. The typical arrangement is to install the valves and tees so that two of the valves are side mounted and one valve is in line. The inline valve becomes the "inline prover valve" and since every drop that goes through the meter must go through the prover system, it is necessary that this valve have special internal seats and seals so that any seal leakage can be detected.



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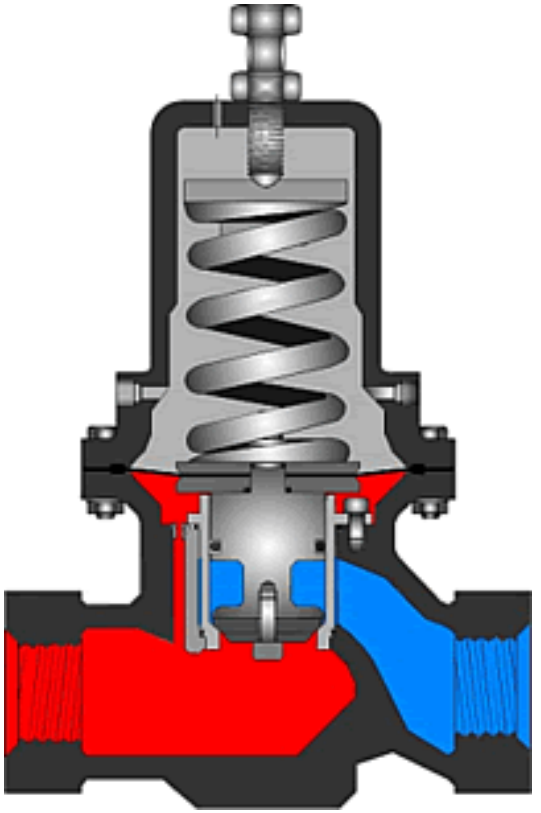
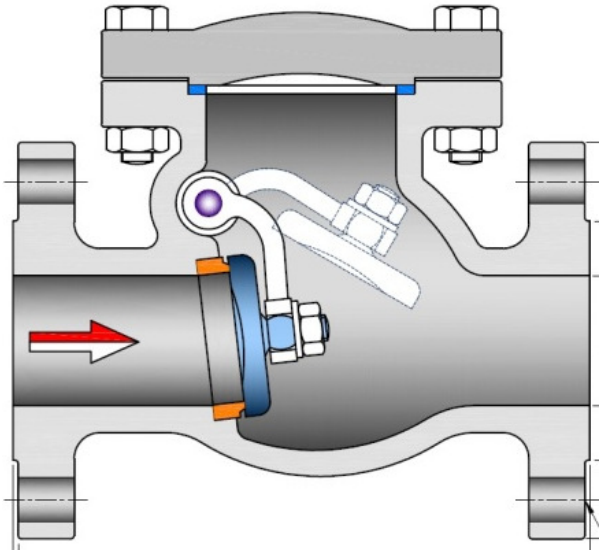
LACT Units - Back Pressure Valve

- The back pressure valve is an automatic valve that is used to hold a minimum pressure against the entire
- The valve is required to ensure that the meter always operates against a pressure above the vapor pressure of the fluid being metered.
- When a centrifugal charge pump is used, the back pressure valve holds a constant pressure against the pump which maintains a constant flow rate on the meter.



LACT Units - Check Valve

- A check valve is used to prevent backflow of metered fluid from the pipeline back through the LACT Unit.
- Check valves should be installed at outlet of the divert line to prevent backflow of fluids and gases from bad oil tanks or production processes (re-treating facilities), and on outlet sales line.
- The check valve is a two-way type valve with a hinged flapper that allows fluid to pass through the valve in one direction only. If fluid were to attempt to flow in the reverse direction, the flapper in the check valve would seat preventing flow.



LACT Units - Isolation Valves

- Isolation valves stops the flow of the process, usually for maintenance or safety purposes.
- Isolation valves are the first and last components on the LACT system.
- Isolation valves should be at the inlet of LACT, outlet of the divert line, and after check valve or last component on outlet sales line.
- These vales allow for the LACT, or any component on the LACT to be serviced without having to drain down pipeline.

LACT Units – Control Panel

- The LACT Control Panel is the electrical brains of the LACT Unit and controls the entire operation of the system. The basic system operates on liquid level switches installed on the "run tank" or "surge tank". When a high level is signaled in the run tank the LACT Control Panel will start the charge pump. Provided there are no problems during operation, the system will run until a low liquid level is signaled and the unit will shut down until the next high level signal is received. In addition to starting and stopping the LACT unit from level switches, the following features are also provided:

LACT Units – Control Panel – Con't

- Main Power On-Off - a circuit breaker or fused disconnect switch to be used to remove power from all electrical devices on the LACT Unit.
- PLC – Programmable Logic Controller to control the LACT operations
- Hand-Off-Automatic Switch - used to run the LACT charge pump in a manual or automatic mode.
- Lightning Arrestor - used to help absorb the electrical surges from lightning.
- Divert Controls - used to position the diverter valve based on signals received from the BS&W
- Monitor.
- Monitor Failure control - used to shutdown the system in the event of a failure of the BS&W Monitor.
- Meter Malfunction Control - used to shutdown the system in the event the meter does not register when the LACT Unit is in operation.
- Set Stop Allowable Control - sometimes used to shutdown the LACT Unit if a preset quantity of product has been delivered through the system.
- Bad oil light and meter failure light.