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L.A.C.T. UNIT PROVING – THE ROLE OF THE WITNESS CLASS

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Introduction

Liquid hydrocarbons removed from the ground must get to market via one of two ways. They are transported via pipeline or tanker truck from production facilities to pipeline systems, which transport the product to the refinery for processing. Once processed, the liquids are once again sent via tanker truck or pipeline to the distribution points downstream. Whether these fluids are purchased or consigned to common carriers, there is transaction called a “custody transfer” conducted to transfer ownership of the product for transportation or distribution. In each of these instances, a representative from each party involved in the “custody transfer” transaction is generally present to observe or “witness” the events of each transaction.

With a “hand run” transaction, both parties witness the measurements taken of the contents of tank being sold. Usually, the production operator takes measurements of the tank and writes a ticket and places it in a box. Later, the truck driver dispatched to load the oil from tank takes measurements and compares them to those taken by the production operator. If they match within a certain tolerance, the tanker truck hauler signs the ticket and accepts the “custody transfer” and loads the oil into his truck.

However, in a L.A.C.T. unit closeout, both parties of the custody transfer are usually present for the meter proving, system verification and sample pot examination and analysis. This is generally done on a monthly interval.

The role of the witness, in the proving of a L.A.C.T. unit, requires that he or she understand the operations of both the L.A.C.T. and ACT units and the device used in proving their accuracy.

Safety

It is the responsibility of the witness to ensure not only his or her safety but the safety of others involved in the act of proving the L.A.C.T. unit. Any safety procedures for the area the witness is in must be followed. If the witness is at some other company’s facility and their procedures are different from yours, the higher level of safety must be observed by the witness.

Generally speaking, if the witness’s safety procedures require the person to wear flame retardant clothing in classified areas and their procedure does not, FRC’s must be worn even if the proving is at their facility.

The proving of a meter requires redirecting the flow of oil through a prover and back into the flow line via a prover tee connection on the L.A.C.T. When using a portable prover, the connecting and disconnecting to the proving loop is something to pay close attention to and observe caution. Most prover connections utilize quick-disconnect couplings that can easily become disconnected under pressure if not properly coupled and latched.

It is important to know and understand these procedures in the event of an unanticipated problem occurring. This procedure must be discussed with each party before each meter proving. Check with your Area Safety Advisor for any written procedures you must follow. Your company may require any third party to attend safety meetings.

General Terms

L.A.C.T.
The term, **L.A.C.T**. stands for Lease Automatic Custody Transfer. That is the automatic transfer of fluid from a lease to a pipeline without the need of outside measurement assistance. The basic design and the operating procedures for L.A.C.T. units are published and available in the Manual of Petroleum Measurement Standards (API).

A.C.T.
The word A.C.T. refers to the Automatic Custody Transfer of fluids other than at a lease unit. Such as a truck meter, pipeline check meter. Pipeline delivery is from one pipeline to another. The basic design and operating procedures are also provided in the Manual of Petroleum Measurement Standards (API)

Meters
Custody transfer quality meters provide an accurate method of dynamically measuring a liquid hydrocarbon fluid flowing through a pipe without stopping the flow. There are a number of acceptable technologies including but not limited to the following.

P.D. (Positive Displacement) meter is a meter that continuously divides the flowing stream into known, discrete volumetric segments, counts each segment and reports this information to a totalizer.

Mass / Coriolis Meter is a meter that typically consists of a pair of matched, dual vibrating tubes bent in various geometries that directly measure mass and density through the Coriolis effect.

Ultrasonic Flow Meter is an inferential meter that determines the velocity of a flowing fluid in a known pipe size. This meter is equipped with multiple transducer pairs positioned in multiple planes, varying angles and distances, which alternately send acoustic signals or sound waves through a flowing fluid upstream and downstream and compare the delta T of the transit time of the sound wave. A sound wave going with the flow travels faster than one going against the flow. The difference in transit time is directly proportional to the fluids mean flow velocity. Multiple transducers located in different planes, different locations on the pipe allow for cross-flow and swirl corrections. Proper flow conditioning both upstream and downstream is required in order to achieve desired accuracy.

Conventional Turbine Meters are inferential measurement devices consisting of a multi-bladed turbine assembly that rotates directly proportional to the flow rate. Proper flow conditioning is required utilizing this technology.

Multi-viscosity or Helical Turbine Meters are inferential measurement devices consisting of a two-bladed turbine assembly that rotates directly proportional to the flow rate. Pulse interpolation is required for utilizing this meter in most cases. This meter is used on higher viscosity, lower API gravity hydrocarbon applications. Proper flow conditioning is required utilizing this technology to achieve desired accuracy.

Prover

A meter prover is a certified measuring device consisting of a calibrated pipe configured in either a straight line or U-tube path. The U-tube design is referred to as a bi-directional prover. The straight-line path can be a unidirectional prover, piston prover or small volume prover.

These devices verify the accuracy of a meter by comparing the registered volume through the meter against the measured volume in the prover. Over registration or under registration is corrected back to 100% volume or “unity”. A multiplier is given to achieve unity, which is given the term “meter factor”.

The volume that passes through the meter is compared to the prover volume during the time taken for a sphere or piston to pass between two detector switches on the prover. Provers may be stationary or portable.

The design of and the procedures for provers are provided in the Manual of Petroleum Measurement Standards (API).

Meter Factor

The meter factor of a meter is established by the comparison of a known, referenced volume to an indicated meter volume. These volumes are subject to a series of calculations using corrections for Temperature, Pressure and Gravity.

The Witness

The Witness must prepare himself, or herself, before attending the proving. First you must know exactly what your company expects from their witness. Prior knowledge of what type of meter and the meter’s history is accentual. You must get involved with the meter proving and verify the information the person operating the prover is going to use to establish your meter factor. Remember, you will be asked to sign the meter-proving sheet when the meter proving is complete. When you sign this document, you are stating that you have witnesses the proving, and all the information used in establishing the meter factor is correct. In order to do that you must have a high degree of knowledge of both, a L.A.C.T. and the meter-proving unit.

L.A.C.T. unit components
Storage tank
Head switch
Filter
Pump and motor
Air loop
S&W probe
S&W monitor
Strainer/air-eliminator
Sampler probe
Sampler system
Divert Valve
Pressure gauges
Thermo-well
Meter
A.T.C. Automatic Temperature Compensator
A.T.G. Automatic Temp/Gravity Compensator
Gross
Temperature Averager
Right angle drive
Totalizer
Prover loop
Valves
Double block and bleed valve
Back-pressure valve
Check valve

Prover components
(General, Bi-directional)
Sphere
Four-way valve
Leak, by-pass, detection
Calibrated Volume
Detector Switch
Connecting hoses
Pressure gauges
Thermo-well
Counters Pick

Meter proving with a portable Bi-directional prover.

Now that we have discussed the various components of L.A.C.T's. and provers, lets discuss the actual proving. As the Witness there are some things that you will want to verify. The prover will perform these duties. The order in which they are done may vary. As the witness you must verify that they are done.

Before the prover connects the lines to the prover tees, you will want to get a line pressure and determine a flow rate. You will compare these readings with those you will have off the prover, to ensure the proving is at normal operating conditions.

Check all seals to see that they are still in good condition since the last proving.

The following items are conducted by the prover but observed by the witness. It is important for the witness to understand his or her role as well as the prover operator's role. Most prover operators have a step-by-step procedure they repeat over and over and are very conscientious at doing so on a consistent basis. Even though it might be tempting to help them connect hoses, turn valves and other activities, it's best for the witness not to assist in this process for safety reasons. Assisting them, noble as it might seem, can cause them to lose their place in their step-by-step process which could result in an accident that nobody wants to have.

1. Safety. When using a portable prover, remember the operator must maneuver the prover truck as close to the proving tees as possible. Generally the connecting hoses are eight to ten feet long. Make sure there are no obstacles in the way, such as piping, electrical conduit, etc. When the prover is in position, make sure the wheels are chocked, and the prover is properly grounded. Grounding is not only a safety concern, but also a possible an electrical problem. Static electricity can cause erroneous counts, premature signal tripping, etc.

2. Prover Connections. The prover will open the drain valve on the double block and bleed to allow oil to flow to verify that the drain is not plugged. Then, he will close the drain valve. He will verify that the hoses are connected securely before opening the prover loop valves.

When using cam locks, or ever-tite fittings, and you have any vibrations they can come loose. It is usually a good idea to "safety-wire" the ears on the camloks in the locked position to prevent an untimely and unexpected release of the connections.

With the connections secure, the operator will slowly open one of the prover loop valves to the prover. Next, he will open the corresponding valve on the prover allowing the prover to reach line pressure. The next step is to open the other prover loop valve and its corresponding valve on the prover. At this time, he will purge any trapped air from the prover.

With liquid flowing through the prover it is time to close the double block and bleed. This will be accomplished by closing the valve slowly while watching the line pressure and the meter. If the pressure goes up and the meter slows down, there might be a valve closed in the system that should not be and will need some sort of attention.

Once the double block and bleed valve closed, open the drain to ensure there is no leakage. If oil continues to come out of the drain, and will not stop, the double block and bleed is leaking, and the proving should be discontinued and reschedule till the valve can be repaired.

3. Bleed air from the system. Switch the four-way valve, or the diverter valve, on the prover to launch the sphere from one side to the other. When the sphere has made it all the way around and is in the other launch chamber, open the air bleeder valves. The bleeder valves are connected to the highest point on each of the launchers. The air must be removed from the prover.

4. Connecting the pulse generator. The pulse generator is an electronic device that screws on the right angle drive of the meter. Connecting the pulse generator to the gear train allows it to transmit a high-resolution electrical pulse to the prover counters. The accuracy of this device can be check by pulse integrate check. This must be preformed for each proving. This integrate check will also check the prover count.

5. Pre-runs. The pre-runs allow the prover piping to reach an equal temperature as the L.A.C.T. unit. It also allows the operator to recheck for air in the system. While making these pre-runs it is a good time to recheck the flow rate and pressure to see that running through a prover will not greatly affect either.

6. Prover runs. The meter needs to have repeatability. Repeatability is the ability of a meter to repeat its registered volume during a series of consecutive proving runs. As a witness you will need to check the counts that come up on the counter, both the half run and the full run.

7. Temperature. Use a certified thermometer to check the prover's temperature device.

8. Gravity. Observe the prover operator as a sample is pulled to verify the observed gravity and observed temperature is recorded. This will be corrected to the A.P.I. gravity and used in the calculations of the meter factor.

9. Pressure. Verify that the pressure gauges on the L.A.C.T. and on the prover are reading the same. Remember that unless the gauges are certified, they may not read exactly the same.

10. Four way or diverter valve leak. Usually there is a gauge connected to the valve that will allow you to verify that the valve is sealing completely and not leaking. This gauge will go to line pressure as the valve is operated, and will go to zero as it reaches closure.

11. Pulse check. The pulse check is separate from the electrical integrity check of the pulse generator. This is check of the meter gear train. The prover operator will take a manual switch, clear the counter, and make a minimum ten barrel run. At the end of the run divide the counter numbers by the number of barrels ran. This number should equal the pulse per barrels used in calculating the meter factor.

12. Calculations. At the conclusion of all the prover runs the prover operator will use the information that was gathered to calculate the meter factor. This will either be done by hand or by an automated or semi-automated process.

Prover Volume Corrections: The certified volume of the prover is determined from a calibration called a Water Draw.
The volume is a zero pressure 60 degree F round trip volume. The volume of the prover has to be corrected to actual conditions.

(Ctl) - Correction for the Temperature of the Liquid
This correction is used to correct the volume of the prover to 60 degree F. This correction is applied to the prover only when the meter being proved is equipped with a mechanical automatic temperature compensator. This is referred to as a net proving. If the meter being proved is not equipped with a mechanical automatic temperature compensator, this correction is applied to both the prover and the meter. This proving is referred to as a gross proving.

(Cps) - Correction for the pressure of the steel
This is a correction applied only to the prover, used to correct for the change in prover volume due to the effect pressure has on steel.

(Cts) - Correction for the temperature of the steel
Correction applied only to the prover too correct for the changes do to the effect temperature has on steel.

(Cpl) - **Correction for the compressibility of the liquid**
(applied to both the prover and the meter.)
Corrects for the effect pressure has on the liquid being proved.

Once the Meter Factor has been established, the L.A.C.T. can be returned to normal operations. First open the Double-Block and Bleed Valve. Second close the two-prover loop valves.

Recheck the pressure and flow rate to see that they are operating at normal conditions.

Verify that all the seals removed to prove the meter is replaced after the proving.

Report the current meter factor to whoever may need to know, such as S.C.A.D.A. control center.

Sign and retain copies of the proving. File and record the meter factor as soon as possible.