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**LACT UNIT PROVING-THE ROLE OF THE WITNESS**
Class # 4080

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## Introduction

*LACT* = Lease Automatic Custody Transfer

A LACT unit automatically transfers liquid hydrocarbons from a lease to a connecting pipeline. Custody transfer means that the ownership of the product changes here, so we are talking about the cash register.

LACT meters are expected to provide a high degree of accuracy. Positive displacement, turbine, and coriolis are the most widely used meter types for custody transfer.

A witness must be aware that certain process variables, such as temperature, rate, and viscosity changes will affect different types of meters differently.

The *LACT* provides two sources of critical information:

1) Quantity- How much?
2) Quality – How much of what?

This paper will address the first part, which involves metering and meter proving.

## Witness

Webster defines witness as both a noun and a verb:

***Witness**: n:* 'A person who attests to the genuineness of a document or signature by adding their own signature.'

***Witness**:* v: 'Attestation of a fact or event; Testimony'

By definition, in order to *witness* a LACT proving, you must first have *knowledge* of what is to be done, for example:

- Industry and company standards
- Things that can possibly go wrong during a proving
- The effect that these things can have on the process

In the end, the witness will sign documents that indicate that they agree with the results of the proving. All too often, the witness is uninformed and simply signs on the dotted line. This is not to suggest that all witnesses be measurement professionals, but they need to know the basics, at the very least. We will discuss a few of the things that a good witness must be aware of.

## Meter Proving

*Meter proving* is a process by which the volumetric meter is periodically checked against a known volume. Anytime we want to determine an unknown, we must first have a known or standard. In most LACT applications, this known volume will be in the form of a volumetric prover. Whether it is a portable, truck mounted unit or a stationary prover, the philosophy is the same. Without getting into prover design, we are comparing our meter's indicated volume to the known volume of the prover, thus identifying the error in the meter by way of a mathematical factor.

**Meter Factor**

A *meter factor* is the multiplier used to correct the meter's indicated volume to the actual volume delivered. The meter factor can be less than 1.0000 if the meter is over-registering or greater than 1.0000 if it is under-registering. The witness should be aware of what conditions can affect the meter factor.

This factor will be used as a direct multiplier for the volumes metered for a given period, so it is critical that the proving process, as well as the resulting calculations, be performed correctly.

**'K' Factor**

Defined as '*Pulses per Unit of Volume'*, this number is used as the devisor that will convert meter pulses to a volume when developing the meter factor.

**Before proving begins**:

- Before flow is introduced to the prover, normal operating conditions *must* be observed and documented. This is important data that will be needed later in the proving. This includes normal flow rate, meter temperature, and meter pressure.
- Make sure that the flow rate is within the range of the meter. Document any temperature or gravity changes since last proving.
- Flow rate will normally drop after flow is introduced to the prover, unless automatic flow control is used. Sometimes the backpressure valve, downstream of the meter and prover, is adjusted to match the proving rate to the normal operating conditions. Care must be taken to maintain adequate backpressure of at least 1.5 times the Reid Vapor Pressure. The proving rate should be within 10% of normal rate.
- The isolation valve to the prover must demonstrate a bubble-tight seal. This valve should provide a double block and bleed, allowing for a visual check. Verify line pressure into a bucket or sump with the valve partially open, closing the main valve. Absolutely no flow from the bleeder should be observed, demonstrating an absolute seal.
- Ensure adequate thermowells and pressure gauges exist on the meter and the prover for verifications during the proving process. During the proving, temperature and pressure at the meter and the prover must be properly identified in order for an accurate volume comparison to be made.
- Industry Standards dictate that the technician use certified, or at least verified, temperature and pressure devices which are traceable to NIST. Find out what your company guidelines are. A good witness will ask to see these documents, maybe even keep a copy for his records.
- Ask to see the current waterdraw certification for the prover. API MPMS recommends a 5 year interval on stationary provers and 3 years on portable provers. These are extreme time frames, since provers may be re-certified sooner due to maintenance.
- Make sure that the base prover volume on the waterdraw report matches that on the proving report. Numbers often get transposed and will result in incorrect calculations, which in turn result in accounting errors.
- A high-speed counter will be gathering pulses from the meter during the proving runs via a high-resolution transmitter, either portable or stationary. Ensure the transmitter's output is verified by the technician. This step, often called the '1000 pulse check', will validate the proper operation of the transmitter. Verifying the transmitter assures us that the correct indicated volume will be used for the proving. This check is too often taken for granted and omitted from the procedure.
- In some locations, high resolution transmitters, like PEXP-1000 or UPT-1000, are used to transfer meter data to an end user, such as a flow computer or PLC. These transmitters should also be verified periodically. The newer UPTs provide dual pulse streams that can be compared within the flow computer. If the two streams get out of phase by whatever tolerance is chosen, an alarm is activated to warn of problems.

## Proving

Prior to initiating the actual proving sequence, it is good practice to make trial runs to:

- Verify the sealing integrity of the 4-way valve or the interchange, (depending on the type of prover). The 4-way must be verified in each direction. This seal must be absolute for a valid volume comparison to be established.
- Ensure that all of the gas is bled off at the high points and that the prover is full of product.
- Allow temperatures to stabilize between the meter and the prover. The actual difference will depend upon the distance between the meter and the prover.

## Volumetric Corrections - Prover

The prover volume is determined by using water, corrected to base conditions, typically 60 deg. F. and 0 psig. The Base Prover Volume is used as a reference, but must be corrected for the conditions at the time of the proving. The API gravity is determined by a spot sample taken from the line. The temperature and pressure for each proving run used in the proving are averaged. The prover wall thickness, inside diameter, and type of steel are also needed, and can be found on the waterdraw certificate. These corrections are:

- CTL-The effect of temperature on the liquid
- CTS-The effect of temperature on the steel of the prover.
- CPS-The effect of pressure on the steel of the prover
- CPL-The effect of pressure on the liquid

The resulting factors are multiplied in sequence to form the ‘CCFp,’ or ‘Combined Correction Factor-prover.’ This factor, when multiplied by the Base Prover Volume, gives us the ‘Net Prover Volume,’ for that particular proving.

## Volumetric Corrections – Meter

The meter volume also has to be corrected to base conditions so that a valid comparison can be made to the prover volume. The temperature and pressure for each proving run used in the proving are averaged. These corrections are:

- CTL-The effect of temperature on the liquid
- CPL-The effect of Pressure on the liquid

The resulting factors are multiplied together, forming the ‘CCFm’ or ‘Combined Correction Factor-Meter’. This factor, when multiplied by the meter’s ‘Indicated Volume’, gives us the ‘Net Metered Volume’ for the same proving.

This allows for a valid comparison between the prover and meter. The prover being the known volume, now corrected to base conditions. The meter is the unknown volume, now corrected to base conditions.

If the metered volume is already temperature compensated, CTL should not be used in the proving calculations for the meter. Temperature compensation can be done mechanically with an ATG or ATC, or through a flow computer.

Net Prover/Net Meter Volume = Mechanical Meter Factor

## Meter Repeatability

Determining meter repeatability is the first task of the proving. This demonstrates whether or not the meter can provide consistent volumetric results. If a meter won’t repeat during the proving, all other possible causes must be eliminated before failing the meter. Often, this is caused by something other than the meter. If this is the case, postpone the proving until the issue is resolved.

Possible causes of non-meter related repeatability issues:

- Trapped gas in the prover
- Inconsistent flow rates
- Improperly sized displacer
- Pulse transmitter problems
- Temperature Instability
- Leaking valves associated with the proving (valve leaks are more often a consistent error and will show up as a meter factor drop)
- Insufficient backpressure (flashing)
- Poorly formed flow profile (turbine meters)

API MPMS requires 5 out of 6 consecutive runs be within .05%, while some companies require 5 consecutive runs. In some cases, averaging 10 or more runs may be acceptable in order to achieve this level of repeatability.

**Meter Malfunction - No Repeatability**

Meter related repeatability issues:

- Foreign matter in meter (trash, paraffin)
- Meter damage due to foreign matter
- Bearing wear
- Gearing wear (skipping or lash)

If the meter doesn't repeat to your company's specifications, gather as many non-repeatable runs, along with the meter and prover temperatures and pressures, as are required. Use an average of these runs, temperatures, and pressures to develop a meter factor.

This factor, averaged with the most recent *valid* factor, becomes the *'malfunction' factor*, and is used to account for the volumes of the past metering period. Some accounting variations exist within the industry as to how this factor is used.

It is necessary to document the malfunction on all reports and tickets. Make sure that the non-resettable totalizer reading is documented.

This meter should not be used until the problem is identified and resolved. After any repairs, the meter should be reproved to establish a new initial factor. Some companies require a mandatory break-in period for certain repairs before proving.

If there are no repeatability issues, a new meter factor is calculated. Industry standards and most companies allow .25%, (.0025), shift from the last valid factor without doing any adjustments. Companies sometime opt to lessen the allowable shift when there are very large volumes involved.

If the factor goes 'out of tolerance', either up or down, a determination as to the cause has to be made. Again, a good witness must be involved in this determination.

**Final Compressibility**

Compressibility for normal operating conditions during the metering period must be applied, either on the ticket or the proving report.

The final CPL may also be applied on the proving report. When multiplied directly by the mechanical meter factor, the result is a ‘composite meter factor’. This correction differs from the proving calculations, since normal operating pressure and temperature are used rather than conditions while flowing through the prover.

This correction can also be applied on the measurement ticket. Either method is acceptable. Often it is mis-applied, used twice or not at all.

In rare cases, pressure correction is applied via a flow computer. If this is the case, the final compressibility should not be applied to the ticketed volume.

**Rising Meter Factors – Causes Include**:

- Increased temperature
- Decreased viscosity
- Wear on internal moving parts
- Decreased flow rate
- Meter pulse transmitter error

**Falling Meter Factors – Causes Include:**

- Prover ball over inflated
- Prover ball under inflated
- Prover isolation valve leaking
- Prover 4-way valve leaking in one or both directions
- Decreased temperature
- Increased viscosity

If the cause is found to be unrelated to the meter, resolve the issue before proving. Unrelated problems should never be reflected in the meter factor.

**Critical Equipment**

**Strainer**

The strainer is one of the most important, yet one of the *most overlooked* pieces of equipment on a LACT unit. The strainer may be located before the charge pump, or on a high point as a strainer/air eliminator combination.

Wherever it is located, it is not designed to filter the oil, but to stop any sizeable debris from getting into or passing through the meter, which will cause measurement error and possible costly repairs.

Straners, like any other piece of equipment in a flowing stream, inherently create a differential pressure. When trash builds up on the basket, surface area is decreased, increasing fluid velocity. When the differential pressure reaches a certain point, the basket will give way and all of its contents are headed for the meter.

It is a good policy to monitor differential pressure across the strainer. After cleaning, the differential will be at its lowest, and should be used as a reference for when the strainer is getting dirty again.

**Air Eliminator**

The air eliminator should be positioned at the highest point on the LACT unit. This is typically atop the API sample loop, where any thermal gasses will accumulate. Sometimes the air eliminator will be in an assembly with the strainer.

Ensure that the vapor line from the air eliminator stays open to drain. If there is a valve on the vent line, make sure that it stays sealed open.

Since typical air eliminators are not designed to remove large volumes of gas, additional equipment may be required if the oil is not weathered.

### Measurement Accuracy

A good witness must understand the importance of accuracy and how it applies to a LACT unit. In this paper, we have discussed some of the more important issues. Factors and corrections are only as good as the data that is used to develop them, whether the reports are hand written or computer generated.

### Site Security

Site security addresses the subject of tampering and the efforts to deter it. Most companies have policies with specific guidelines as to what is to be sealed on a LACT. In some cases, seal logs must be kept current and updated each time that a seal is broken and/or replaced. In some cases, inspectors lacquer may be acceptable to use on points that are not feasible to drill for sealing.

PLC and flow computer security is also an issue when remote access is possible.

### Conclusion

It is a good witness's responsibility to help identify measurement problems and bring them to the attention of the appropriate supervision. It is a Company's responsibility to provide the training needed to get these key people to the level required to be a good witness.