Custody Transfer from Onshore Oil and Gas Small Lease Tanks

By Michael Machuca

Manual tank gauging is prevalent in onshore oil and gas facilities in the United States and is viewed as a cost-effective solution to manage tank inventory and custody transfer measurements. The API MPMS Chapter 18.1 standard provides guidance for how these measurements are made, but there is increasing concern around accounting accuracy, production losses and safety. Operators are also looking to reduce costs and increase cash flow by better managing tank transfers, logistics, and inventory.

SAFETY

Manual tank gauging presents a number of health and safety concerns associated with frequent field trips, working under harsh seasonal weather conditions, and cumulative exposure to volatile organic compounds (VOCs). For example, opening tank thief hatches can lead to the rapid release of high concentrations of hydrocarbon gases and vapors. This may result in very low oxygen levels and high toxic H2S levels, as well as flammable conditions around and over the tank thief hatch. Workers have experienced dizziness, fainting, headaches, nausea, and even death while gauging tanks, collecting samples, or transferring fluids. National Institute for Occupational Safety and Health (NIOSH) researchers and Occupational Safety and Health Administration (OSHA) officials are investigating these cases and other reports of worker deaths (9 identified 2010-2014) associated with manual tank gauging and sampling operations. Eliminating hand-gauging and utilizing automated technology can reduce the risk to workers as outlined in the recent NIOSH-OSHA Hazard Alert (Figure 1). In addition, better insight into tank inventory levels can reduce the risk of spills and optimize transfer logistics, reducing road traffic hazards.


NIOSH-OSHA
HAZARD ALERT
Health and Safety Risks for Workers Involved in Manual Tank Gauging and Sampling at Oil and Gas Extraction Sites

***Figure 1:** NIOSH-OSHA Hazard Alert*

WHY API MPMS CHAPTER 18.2

Until recently, the only small lease tank custody transfer method other than API MPMS Ch. 18.1 for manual tank gauging was to install a lease automatic custody transfer (LACT) unit per API MPMS Ch. 6.1, which can be uneconomical on sites with low production volumes. To address this, API has released a new standard API MPMS Ch. 18.2 which provides guidance for crude oil custody transfer from lease tanks using alternative measurement methods. The goal of API MPMS Ch. 18.2 is to allow the use of existing technology and standards for custody transfer without opening the tank thief hatch in order to increase safety. API Ch. 18.2 has defined three zones where the quantity and quality of oil being loaded from a lease tank to a truck trailer can be measured. The zones are depicted in Figure 2 and are defined as the tank zone, transition zone, and trailer zone:

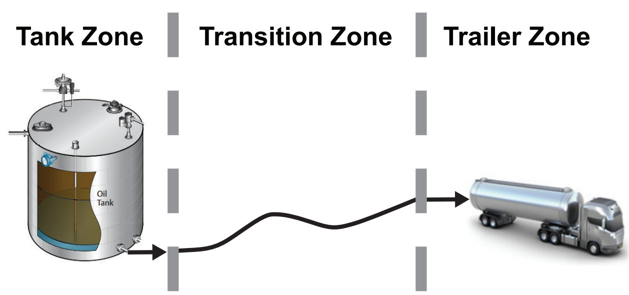

***Figure 2:** API 18.2 Zones*

Tank Zone:
Defined as the tank interior and any equipment attached to it. The tank zone ends at the outlet valve.

Transition Zone:
Defined as the area between the tank and truck during custody transfer. The transition zone ends at the inlet valve of the trailer.

EMERSON
Process Management

Trailer Zone:
Defined as the trailer interior after a product has left the transition zone. The trailer zone begins at the inlet valve of the trailer.

API MPMS Ch. 18.2 requires measurement of the data below for custody transfer, which can be done using equipment located in one or multiple zones.

- Merchantability
- Indicated/observed volume
- Product temperature
- API gravity and observed temperature
- Suspended S&W
- Calculated volume (GSV and NSV) (refer to API MPMS Ch. 12)

API MPMS Ch. 18.2 recommends creating a list of existing and/or available equipment for each zone and documenting the equipment uncertainty used to determine the quantity and quality of crude oil. Section 13.2 outlines a process for calculating the overall uncertainty of the custody transfer operation. The data can then be used to develop a method that minimizes overall measurement uncertainty while meeting contractual obligations. Due to the different types and possible permutations of potential devices on the market, this paper will focus on the indicated volume measurement using the two most common methods, automatic tank gauging and LACT units.

AUTOMATIC TANK GAUGING

One of the solutions in the tank zone is automatic tank gauging. While there has been an existing standard API MPMS Ch. 3.1B for automatic tank gauging for custody transfer measurement, this standard was designed for large storage tanks with requirements uneconomical for small lease tanks. API MPMS Ch. 18.2 address the unique requirements of small lease tanks in onshore operations by referencing the existing API MPMS Ch. 3.1B standard practices, but with reduced accuracy requirements associated with API MPMS Ch. 18.1. This allows using instruments more suitable and economical for the application, such as guided wave radar. Guided wave radar has traditionally provided validation of well production rates, off-lease transfers of produced water, and tank gauging operations for oil custody transfer. Many operators have standardized on using guided wave radar and have an existing installed base of instruments. Operators can now see additional benefits by adopting the technology for custody transfer. They will also need to develop procedures for obtaining product quality measurements in the transition zone to achieve the safety benefits of keeping their personnel off the tanks. API MPMS Ch. 18.2 Section 10.2 outlines various options and existing standards to determine oil quality. There are additional benefits to minimizing manual tank gauging, such as improved accuracy and reduced potential for production losses.

AUTOMATIC TANK GAUGING ACCURACY AND LOST PRODUCTION BENEFITS

Manual tank gauging requires high operator competency, is subject to human errors, and often must be taken under difficult weather conditions. When oil is hauled off the lease site, the operator often must ensure that the volume delivered is not less than what was measured to be contractually compliant. This can lead to rounding off open and end level measurements, which can introduce lost and unaccounted-for production errors. For example, a 1-percent error in tank gauging on a typical shale production well producing 900 bbl/d represents an annual fiscal exposure of $164,000 at $50 per barrel of oil (Figure 3). One operator's efforts to verify the extent of measurement variability within a team of experienced gaugers indicated volume discrepancies as high as ±8 percent.

Manual Gauging	
Production Rate	900 bbl/d
Gauging Error (%/haul)	1.0%
Volume Error (bpd)	9
Daily Exposure	$450
Annual Exposure	$164,250

Figure 3: *Manual gauging error*

Lack of visibility to production separator upsets will send oil to the water tank or water to the oil tank. If not detected, oil in the water tank will be lost, especially if using a third-party water hauler during water transfers. Unaccounted-for or unauthorized hauling of produced oil in the water tank from a multiple well pad facility could reach over $1,000,000 a year in lost revenue if not accurately monitored and recovered (Figure 4). Excess water can lead to an unexpected oil tank capacity loss resulting in a spill or well shut-in from a high level alarm.

Oil Skim Losses	
Well Pad Production (bpd)	5,400
Estimated Skim Losses %	1.0%
Lost Production Volume (bpd)	54
Lost Production Revenue ($US/day)	$2,700
Annual Impact ($US/year)	$985,500

Figure 4: *Estimated skim losses on a 6-well pad, 900 bpd/day.*

Many operators are now realizing the economic benefits of automated level measurement solutions, such as guided wave radar, to ensure accurate inventory measurements, prevent spills, optimize transfer logistics, and verify custody transfer measurements. Leveraging wireless guided wave radar technology has added advantages that reduce installation costs by as much $24,000 on a four-well pad, according to a recent case study by WPX Energy. Diagnostic capabilities and interface measurements can be utilized to detect if oil or water has been transferred to the wrong tank to minimize lost production and provide insight to correct separator problems.

LACT UNITS FOR LARGER FACILITIES

Lease Automatic Custody Transfer, (LACT units) are another method to transfer ownership of crude oil from production facilities to pipelines or trucks and have many advantages compared to most other custody transfer methods. A LACT system offers unattended measurement with a maintained accuracy of ±0.25 percent or better. In addition, it makes for better use of labor, better scheduling of runs to pipelines, elimination of measurement errors due to tank bottom build-up or encrustation, and reduction in operating and maintenance costs.

With LACT units, the flow meter must measure and quantify the fluid with a high accuracy. It must be insensitive to high viscosity values and maintain the requested level of accuracy and reliability even with changing conditions and operating parameters. Meter technologies, such as Coriolis, are designed to overcome these types of challenges and provide stable measurement and proving results over extensive service periods.

Effective validation through proving operations (pipe provers, compact provers) will ensure on-going meter accountability while advanced in situ diagnostics, available for Coriolis meters, help identify abnormal events that compromise measurement between validations. LACT units are usually installed in remote locations and are almost always unmanned. It is important to have remote accessibility to all data and operating conditions.

Operators ask themselves when it makes economic sense to invest in a LACT unit versus manual tank gauging or automated tank gauging. Many install LACT units only when a field exceeds a company's standard production rate to reduce fiscal measurement uncertainty and help automate larger volume transfers. A typical LACT system has the capability of a ±0.25 percent accuracy. Compare that to manual gauging with an accuracy of 1 percent in Figure 5 and you can determine the amount of annual fiscal exposure and production rates versus the time in months it takes to pay for the installation of a LACT unit. In this chart, a 1 percent error for manual gauging was used. But in many cases, operators have reported errors up to ±8 percent. Other considerations not included in the calculation are the cost associated with manual operations and measurements that can also justify LACT unit installation.

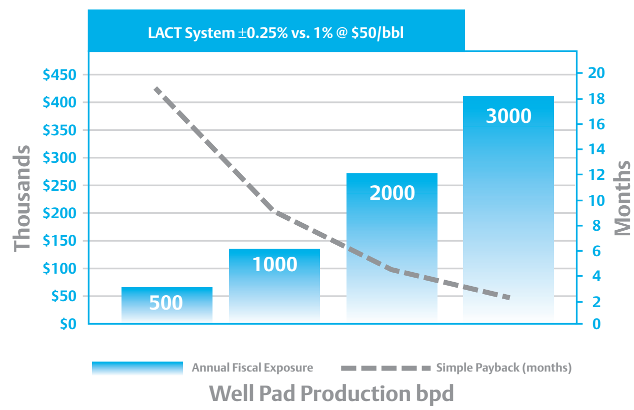

Figure 5: *LACT unit payback in months*

Another option with the addition of API MPMS Ch. 18.2 is truck-based LACT systems (Figure 6). Truck-based LACT systems can reduce the capital cost of permanent skid-based LACT systems, but are subject to potential damage from traveling on oilfield roads. It is critical that any truck-based system be properly maintained and inspected to ensure measurement accuracy.

Figure 6: *Truck LACT unit*

AUTOMATION SYSTEMS

No matter which method of custody transfer is chosen, all instruments and diagnostics can be brought into a central controller or RTU for remote access or direct access on site. Human machine interfaces can be used to automate haul transactions using manual or automatic tank gaging or LACT based systems. Integrating functionality into automated production management and tank management programs has proven to eliminate issues around production measurement compliance, as well as minimize lost and unaccounted-for production. A recent article in Automation World highlights where Marathon saved close to $15 million by formalizing and automating metering at their production tanks. Better insight and early identification of uncertainties can help contain ownership costs and reduce fiscal risk. Solutions for remote operations include flow computers and RTU platforms with flexible software applications and SCADA systems to monitor the process of fluid transportation (Figure 7).

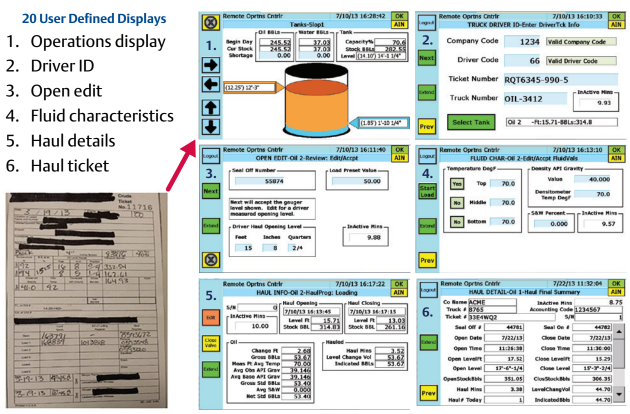

Figure 7: *Well pad tank management haul interface*

CONCLUSIONS

The application of wired or wireless automatic tank gauging technology, such as guided wave radar for continuous level monitoring, improves production management by enhancing operations. Continuous insight into actual inventory levels helps avoid reactive operator events associated with high-level alarms, well shut-ins, or a tank overfill situation. Oil losses to water storage tanks and diminished storage capacity due to excessive water levels in oil tanks are minimized through oil/water interface detection. With the publication of API MPMS Ch. 18.2, there is now an industry-acceptable path that uses guided wave radar for crude oil custody transfer from small lease tanks.

Where economical, the installation of a LACT-based custody transfer system can pay for itself with reduced measurement uncertainty and better use of labor. With the addition of API MPMS Ch. 18.2, many operators are also implementing truck-based LACT systems that reduce the capital cost of flow measurement-based systems.

Leveraging automation systems and standards based applications for well pad tank management have the added benefit of bringing all the measurement systems together to maximize overall efficiency and reduce fiscal risk.

Emerson Process Management
1100 W. Louis Henna Blvd.
Building One
Round Rock, TX 78681
www.EmersonProcess.com

EMERSON
Process Management