WHO IS MANNING THE CASH REGISTER? PART 1

We all are painfully aware of the decrease in crude oil and natural gas prices. . Many of the smaller companies have gone bankrupt. Most companies have had significant reductions in the number of employees to perform the necessary work. Some major oil companies have had reductions in force of 40 percent, I personally experienced a 40 percent reduction back in the early 1990's. I was one of the survivors of the cutback, but I felt guilty as a survivor and very sad for my fellow employees who needed their job to feed their families. The workload remained the same with fewer employees to perform the tasks. Many employees' workload doubled or even tripled. Can you relate? Often these situations lead to early retirements, without the proper backfill of employees with adequate training to perform the work correctly. Training is typically the first thing that corporations cut, leaving a gaping hole in getting the job done correctly and on time meeting all of the government regulations. With the income stream down due to the low commodity prices, who can afford the fines for not properly following the regulations? Is this happening in your company? Custody transfer measurement is the cash register of the company, and you have to ask "Who is manning the cash register?". Is that person trained to oversee that the custody transfer measurement is handled correctly? Does your company even have an employee witness the custody transfer measurements to make sure they are performed correctly?

Measurement of crude oil and natural gas is a very important task, which has a direct impact on the bottom line of the corporation. Crude oil is produced from reservoirs often deep below the surface. The produced fluids generally consist of a mixture of oil, natural gas and water. In the production field, separators and possibly heater treaters are utilized to separate production fluid into an oil stream, a natural gas stream and the sediment and water. The water may be utilized for water flooding as part of reservoir stimulation to enhance the amount of oil produced. The water may be injected into a disposal well, or it may be hauled away to a disposal site.

Traditionally the oil is sent to storage tanks to "weather" prior to sales, to meet the pipeline tariff requirements. Most pipeline tariffs require 24 hours of "weathering" before the oil can be sold. Weathering provides the necessary time for the light ends (gaseous hydrocarbons) to escape the oil. This is similar to the CO_2 bubbles escaping when you first pour a Coke into a glass. It also allows sufficient time for the sediment and water still entrained in the oil to fall to the bottom of the tank.

For decades crude oil has been sold either by tank gauging or by metering. The first custody transfer measurement occurs at the production battery. The production company personnel typically will gauge the tank for inventory purposes. A pipeline gauger or truck driver will gauge the isolated tank to determine the quantity and quality of the oil being sold. The outlet valve on the tank is then opened and the oil is transferred into a pipeline or a truck to be transported to a pipeline station. Once the oil leaves the tank the oil now belongs to the pipeline. On the surface this sounds very simple however; there are many steps that must be performed correctly for the proper quantity and quality to be determined. All of the necessary steps for tank gauging are covered in American Petroleum Industry Manual of Petroleum Measurement Standards (API MPMS). The following API MPMS Chapters must be understood by the employee and properly performed for the correct gauging quantity results to be obtained.

- API MPMS Chapter 2-- Tank Calibration, Section 2A – Measurement and Calibration of Upright Cylindrical Tanks by the Manual Tank Strapping Method.
- API MPMS Chapter 2.2E, Petroleum and Liquid Petroleum Products--Calibration of Horizontal Cylindrical Tanks Part 1: Manual Methods.
- API MPMS Chapter 2.2F, Petroleum and Liquid Petroleum Products--Calibration of Horizontal Cylindrical Tanks Part 2: Internal Electro--optical Distance –ranging Method.
- API MPMS Chapter 3.1A, Standard Practice for the Manual Gauging of Petroleum and Petroleum Products.
- API MPMS Chapter 3.1B, Standard Practice foe Level Measurement of Liquid Hydrocarbons in Stationary Tanks by Automatic Tank Gauging.
- API MPMS Chapter 3.6, Measurement of Liquid Hydrocarbons by Hybrid Tank Measurement Systems.

The following API standards must be understood and properly performed to obtain the proper quality results.

- API MPMS Chapter 7, Temperature Determination.
- API MPMS Chapter 8.1, Standard Practice for Manual Sampling of Petroleum and Petroleum Products.
- API MPMS Chapter 9, Density Determination Section 3--Standard Test Method for Density, Relative Density (Specific Gravity) or API Gravity of Crude Petroleum and Liquid Petroleum Products by Thermohydrometer Method.
- API MPMS Chapter 10.4 Sediment and Water Determination by Field Centrifuge.

These standards cover the necessary information for the proper quality measurements to be made in the field if followed carefully. For example, if the sample is not representative for any reason the

quality test results will not be accurate. Standard procedures that work at the majority of locations may need to be changed for certain types of oil. Both paraffinic and Asphaltenic oils require water saturated toluene or xylene be utilized. The centrifuge temperature may need to be increased as well in order for the paraffin to melt and not be counted as sediment. Sun Exploration and Production Company had to require the referee method (water by distillation and sediment by extraction) be performed by an independent third party because of a disagreement in the results with Sun Pipe Line. The referee method confirmed that water saturated toluene and additional heat was required to obtain accurate results. Similarly, a client I taught for in Alaska had a similar issue. As part of the class, we did hands on sediment and water tests on the clients' oil and demonstrated the results of the sediment and water centrifuge test with three different solvents and different temperatures. The company let me know that by utilizing the information I taught them it saved them $80,000 per month, because the paraffin was no longer being counted as sediment. Without a knowledgeable witness knowing the API measurement standards well, both of these mismeasurements would have gone on for years and the bottom line would suffer. In the Alaska example above, the bottom line would be missing $960,000 at that one location in one year, because of uninformed employees.

Sun Exploration and Production Company typically maintained 7 days of storage of the daily production on the lease, so that disruptions could occur without having to shut--in any wells. Flooding after a major storm is one possible reason for a disruption. As I write this article, Texas is experiencing many locations of major flooding and forced evacuations. Nine soldiers at Fort Hood died in a training exercise as they made a low water crossing and got swept away. Major highways have been closed for several days due to high water on the roadway in several areas of the state, causing major traffic issues. Flooding may prevent trucks from hauling oi from the production site to the pipeline site in a timely manner. (Sometimes when a well is shut--in it does not produce as well as it did prior to the shut--in and thus the company decision to maintain 7 days of storage.) Another possible cause of disruption is train derailments. On June 3, 2016 a 96 rail car train hauling Bakken crude to refineries in Washington State derailed on the Oregon side of the Columbia River Gorge. Bakken crude is known to be more flammable than a lot of crude oils because of the higher content of entrained gas, which results in a higher vapor pressure and a lower flash point. Four of the twelve cars that derailed caught fire sending a large plume of smoke into the air which was seen for miles. Additionally, this derailment shut down 23 miles of interstate 84 and caused a school evacuation. The cleanup after a train derailment can take a long time, depending on the number of rail cars involved the length of time it takes to either let the fire burn out naturally or safely put it out, and the repair of the tracks. Consequently, this type of disruption can take days to weeks to return to service. Another potential disturbance is an oil tank fire caused by a lightning strike, which often spreads to the other tanks on the lease, shutting in the lease until the storage tanks can be replaced, which may also require a significant amount of time.

Today the landscape has changed dramatically, due to a number of factors. Company decisions are being based on new regulations from the federal government in the area of environmental, health and safety as well as new Onshore Order 3, 4 and 5 covering measurement on Bureau of Land Management or Federal Lands which will be implemented soon. For example, today companies have to build a berm around the perimeter of the tankage which is capable of containing the contents of the total number of tanks when full plus the maximum recorded 24 hour rain recorded in that area. Thus, many companies are utilizing fewer tanks on-site to minimize the berm requirements as well as reduce the capital expenditure at the lease. Fewer tanks also minimize the greenhouse gas issue as well. Today the greenhouse gases escaping at the production site, including tanks, rotating equipment, volatile organic compound burners and flares are required to be measured or estimated and reported to the federal government. (Bureau of Land Management in NTL 4a, EPA in CFR T40, P70 and P71 regulations detail how these gases are accounted for and reported on a yearly basis.) One way to minimize the greenhouse gases is to minimize or eliminate the weathering time. A significant improvement in reducing greenhouse gases is to minimize the tankage on site where vapors can escape from tank hatches. Fewer tanks on site mean less greenhouse gas exposure and thus many companies are reducing on-site tankage.

Another major change in the landscape is the shale production, which frequently occurs in areas with little if any infrastructure. If there are no pipelines, trucks or railroads will be required to transport the oil from the field production sites to either a pipeline station or to a transportation hub. In some remote locations in Texas, the oil is hauled by truck to a railroad facility where it is loaded and then transported via rail to a refinery. When the oil is unloaded, it will be measured again. When the oil is hauled by truck to the pipeline station, the oil will be measured as it is offloaded. The oil will then be pipelined to a refinery for fractionation into the various products. The oil will be measured at the refinery as well as potentially at intermediate pipeline locations.

Lease crude oil tanks

An aerial view of an oil train that derailed in the Columbia River Gorge near Mosier, Oregon, June 3, 2016.

Landowners want to minimize the space required for the production site to maximize their use of the land. Advances in drilling and fracking technologies allow multiple wells to be drilled in a small area, while the wells provide a large access to the reservoir. To further minimize cost and greenhouse gas issues, many companies are moving the oil from these well pads to a central facility for separation to take advantage of economy of scale efficiencies, by minimizing the amount of equipment required for both the producer and the pipeline company. There is even a trend in the industry to measure "live" oil at the

Smoke plume from Columbia River Gorge train derailment

central facilities. "Live" oil can be defined as oil that has not been weathered and may have sediment and water contents above the normal pipeline limits. Also the oil is potentially still at pressure minimizing the need for pumps to get the oil into the pipeline. Many new shale wells are in areas that contain hydrogen sulfide, which is known as sour oil. Hydrogen sulfide, H_2S is dangerous and the federal government has limits on the levels that employees can be exposed to. Officially the limit is now 10 ppm over an 8 hour shift which has been reduced from 20 ppm previous limit, but many corporations require the employee to leave the area if their H_2S monitor goes off at the 10 ppm level. In areas where the oil is sour, most companies utilize either automatic tank gauging or a LACT to minimize employee exposure to H_2S. A new solution is hydrostatic tank gauging which is covered by API MPMS Chapter 16.2. An innovative example of this technology is the W. L. Walker Co, Inc. Tulsa Thief System™ (patents pending), which is comprised of a fixture (spool) with ports for the measurement input devices. These fixtures can be mounted on the tank, in the zone between the tank and the truck, and at the trailer. The system is controlled by the e--Thief™, which is a portable device. The e--Thief™ device collects the measurements in any of the three zones, utilizing a digital thermometer, a sampling port, and a hydrostatic pressure transducer. The e--Thief™ inputs the data directly, or prompts the user to enter measured values. A significant advantage to this system is the ability to measure quantity and quality of the crude oil before breaking the seal of the tank and was designed to fit the needs of crude haulers and gaugers.

Especially in H_2S areas it makes a lot of sense to minimize tankage and exposure to the oil, another reason to measure "live" oil. Another issue that has been encountered is that the initial production from the horizontally drilled wells may exceed the tankage installed. In some shale areas, some operators are going "tankless" and "ventless" utilizing closed systems as described previously. Some emerging technologies are becoming available which allow accurate quantity and quality determination of the product without gauging tanks utilizing conventional methods. Some operators are utilizing new technologies, which may or may not have an API standard written for them. API MPMS Chapter 18.2 Custody Transfer of Crude Oil from Lease Tanks Using Alternative Measurement Methods is currently in the ballot stage. The standard breaks the process into three areas; tank zone, transition zone and the trailer zone. The standard allows either manual gauging or ATG (automatic tank gauge) of the trailer to determine the volume of product loaded onto the truck. The calibration of the trailer should be performed according to either API MPMS Chapter 2.2E or 2.2F.

e-Thief™ tank measurement system

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Jane Williams has over 40 years of experience in the oil and gas industry and has been very involved in the development of industry standards. She has a master's degree in engineering and has a tremendous amount of field experience. Jane's vast knowledge allows her to explain difficult concepts in an easy to understand manner.

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