ELECTRONIC GAS MEASUREMENT AUDITING

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Introduction

Electronic Gas Measurement or EFM auditing is a very important process of the natural gas industry. Only a few short years ago, the dry flow chart recorder was the "state of the art" recording device for custody gas measurement.

All that has changed with the advent of the flow computer; volumes are recorded and generated at the field level, and imported to the measurement system. Careful review of meter data should be part of the monthly close process.

Define the Process

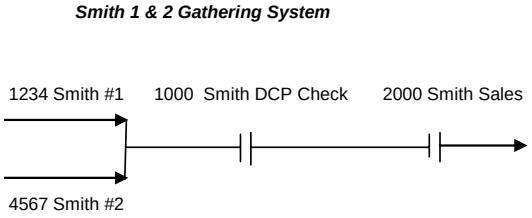
A successful audit program depends upon a lot of different variables. The key to success is consistency, proper documentation, and a good field measurement program.

You do not need an elaborate computer system to maintain and review monthly system balances. However, your system should be able properly account for all of your gas in a system.

Here is a general outline of the auditing procedure:

- Document all receipts and deliveries in the system. Be sure to include any field uses.
- Generate a schematic of the system. A simple "stick diagram" of the system is extremely helpful. Have the field measurement technician review and confirm that the system accounts for all the gas in the system.
- Setup your balance systems or segments in your reporting program. Spread sheets will work, if a measurement system is not available.
- Compare the sales volumes to the system volumes. If you suspect an error, prepare a written request for audit material.
- Be specific in your written request for data. Include the meter number, station name, production dates, and the types of files that will be required to perform the audit.
- Conduct your review; if an error is detected, submit your findings to the purchasing company. Be specific in your request; state the amount of adjustment you are requesting, and the reasons why the adjustment is warranted.
- Once the adjustment has been reviewed, approved and received, notify all downstream users of the adjustment via a prior period adjustment notice. This notice will state the original volume, the net adjustment, and the final agreed upon volume.
- Log or record your adjustments in your measurement system. Be sure to include any reasons for the adjustments. They may be helpful in later months, and they may help to identify a re-occurring problem.

Example Gas Schematic



Chapter 21

Errors that occur in EFM devices are no different than errors that can occur in a chart recording. The calculation data and configurations must be correct in order to compute a correct volume. Fortunately, API Chapter 21.1 defines the standards for audit and reporting requirements for EFM devices. While there are many different brands of recorders on the market, this standard serves as the guide for the industry.

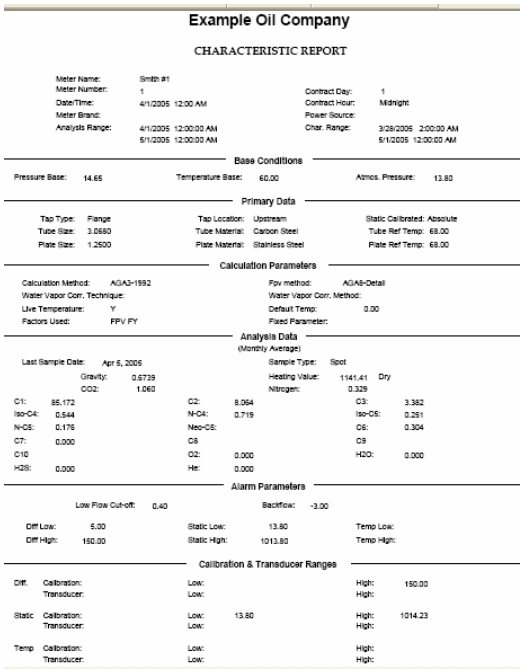
Most EFM devices today, provide a quantity transaction record, configuration, alarms, and events logs as part of the audit trail. However, in order for these records to be accurate, there must be good coordination between the field technician, and the office. Before the meter is installed or configured, the contract terms should be reviewed and sent to the field technician. This will define the configuration information that will be needed to be entered into the flow computer.

Potential Errors

Volumetric discrepancies can be caused by many variables. While the EFM device provides the "secondary" measurement, always keep in mind that if a problem or error persists, it may not be in the meter. It could be caused by a problem in the primary element.

Here are some considerations to follow when auditing the configuration of an EFM device:

- Carefully review the configuration data. The meter configuration defines how the meter will compute the volumes. The meter configuration setup should be defined by the contract terms.
- Meter configuration parameters include: pressure base, atmospheric pressure, AGA calculation method, Supercompressibility method, meter recording ranges, gas quality information, and primary element size.



Example Oil Company

CHARACTERISTIC REPORT

Meter Name: Smith #1
Meter Number: 1
Date/Time: 4/1/2005 12:00 AM
Meter Brand:
Analysis Range: 4/1/2005 12:00:00 AM – 5/1/2005 12:00:00 AM
Contract Day: 1
Contract Hour: Midnight
Power Source:
Char. Range: 3/28/2005 2:00:00 AM – 5/1/2005 12:00:00 AM

Base Conditions

Pressure Base: 14.65 Temperature Base: 60.00 Atmos. Pressure: 13.80

Primary Data

Tap Type: Flange Tap Location: Upstream Static Calibrated: Absolute
Tube Size: 3.0680 Tube Material: Carbon Steel Tube Ref Temp: 68.00
Plate Size: 1.2500 Plate Material: Stainless Steel Plate Ref Temp: 68.00

Calculation Parameters

Calculation Method: AGA3-1992 Fpv method: AGA8-Detail
Water Vapor Corr. Technique: Water Vapor Corr. Method:
Live Temperature: Y Default Temp: 0.00
Factors Used: FPV FY Fixed Parameter:

Analysis Data (Monthly Average)

Last Sample Date: Apr 5, 2005 Sample Type: Spot
Gravity: 0.6739 Heating Value: 1141.41 Dry
CO2: 1.060 Nitrogen: 0.329

C1:	85.172	C2:	8.064	C3:	3.382
Iso-C4:	0.544	N-C4:	0.719	Iso-C5:	0.251
N-C5:	0.176	Neo-C5:		C6:	0.304
C7:	0.000	C8		C9	
C10		O2:	0.000	H2O:	0.000
H2S:	0.000	He:	0.000		

Alarm Parameters

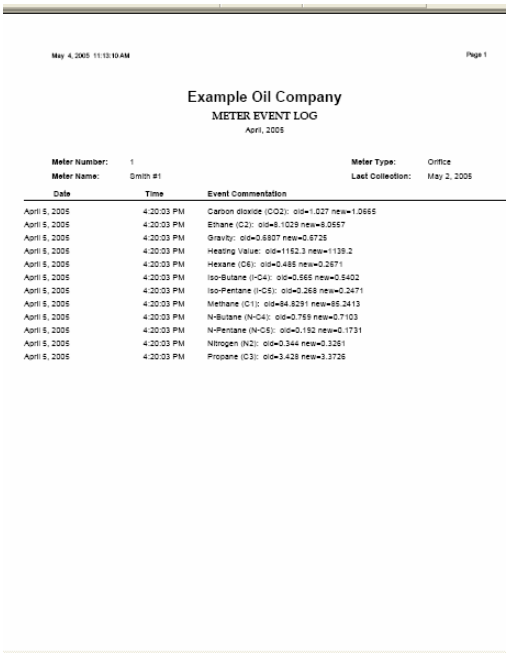
Low Flow Cut-off: 0.40 Backflow: -3.00

Diff Low:	5.00	Static Low:	13.80	Temp Low:	
Diff High:	150.00	Static High:	1013.80	Temp High:	

Calibration & Transducer Ranges

Diff.	Calibration:	Low:		High:	150.00
	Transducer:	Low:		High:	
Static	Calibration:	Low:	13.80	High:	1014.23
	Transducer:	Low:		High:	
Temp	Calibration:	Low:		High:	
	Transducer:	Low:		High:	

- Event logs. These logs contain valuable information pertaining to the operation of the station. The events logs may include the meter test, high flowing pressures, and possible failures of the FM.



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Example Oil Company

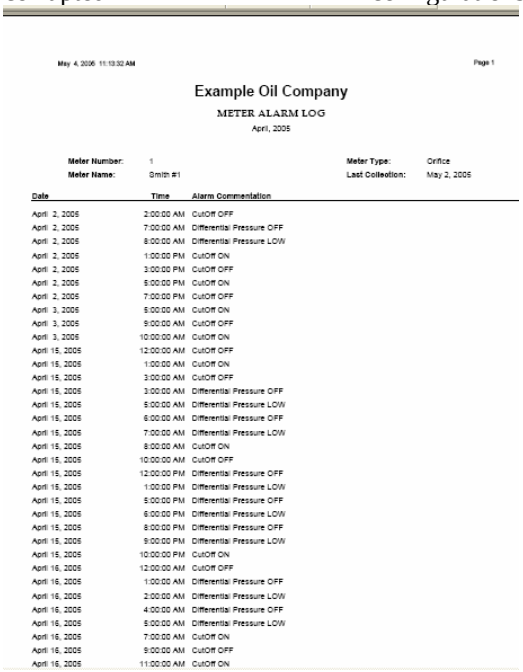
METER EVENT LOG

April, 2005

Meter Number: 1 Meter Type: Orifice
Meter Name: Smith #1 Last Collection: May 2, 2005

Date	Time	Event Commentation
April 5, 2005	4:20:03 PM	Carbon dioxide (CO2): old=1.027 new=1.0665
April 5, 2005	4:20:03 PM	Ethane (C2): old=8.1029 new=8.0567
April 5, 2005	4:20:03 PM	Gravity: old=0.6807 new=0.6725
April 5, 2005	4:20:03 PM	Heating Value: old=1152.3 new=1139.2
April 5, 2005	4:20:03 PM	Hexane (C6): old=0.485 new=0.2671
April 5, 2005	4:20:03 PM	Iso-Butane (I-C4): old=0.565 new=0.5402
April 5, 2005	4:20:03 PM	Iso-Pentane (I-C5): old=0.268 new=0.2471
April 5, 2005	4:20:03 PM	Methane (C1): old=84.8291 new=85.2413
April 5, 2005	4:20:03 PM	N-Butane (N-C4): old=0.759 new=0.7103
April 5, 2005	4:20:03 PM	N-Pentane (N-C5): old=0.192 new=0.1731
April 5, 2005	4:20:03 PM	Nitrogen (N2): old=0.344 new=0.3261
April 5, 2005	4:20:03 PM	Propane (C3): old=3.428 new=3.3726

- Alarm logs permit the auditor to review any potential problems during the operation of the flow computer during the production month. These may include over ranging of operating pressures, rates, battery voltage, or lost or corrupted configurations.



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Example Oil Company

METER ALARM LOG

April, 2005

Meter Number: 1 Meter Type: Orifice
Meter Name: Smith #1 Last Collection: May 2, 2005

Date	Time	Alarm Commentation
April 2, 2005	2:00:00 AM	CutOff OFF
April 2, 2005	7:00:00 AM	Differential Pressure OFF
April 2, 2005	8:00:00 AM	Differential Pressure LOW
April 2, 2005	1:00:00 PM	CutOff ON
April 2, 2005	3:00:00 PM	CutOff OFF
April 2, 2005	5:00:00 PM	CutOff ON
April 2, 2005	7:00:00 PM	CutOff OFF
April 3, 2005	5:00:00 AM	CutOff ON
April 3, 2005	9:00:00 AM	CutOff OFF
April 3, 2005	10:00:00 AM	CutOff ON
April 15, 2005	12:00:00 AM	CutOff OFF
April 15, 2005	1:00:00 AM	CutOff ON
April 15, 2005	3:00:00 AM	CutOff OFF
April 15, 2005	3:00:00 AM	Differential Pressure OFF
April 15, 2005	5:00:00 AM	Differential Pressure LOW
April 15, 2005	6:00:00 AM	Differential Pressure OFF
April 15, 2005	7:00:00 AM	Differential Pressure LOW
April 15, 2005	8:00:00 AM	CutOff ON
April 15, 2005	10:00:00 AM	CutOff OFF
April 15, 2005	12:00:00 PM	Differential Pressure OFF
April 15, 2005	1:00:00 PM	Differential Pressure LOW
April 15, 2005	5:00:00 PM	Differential Pressure OFF
April 15, 2005	6:00:00 PM	Differential Pressure LOW
April 15, 2005	8:00:00 PM	Differential Pressure OFF
April 15, 2005	9:00:00 PM	Differential Pressure LOW
April 15, 2005	10:00:00 PM	CutOff ON
April 16, 2005	12:00:00 AM	CutOff OFF
April 16, 2005	1:00:00 AM	Differential Pressure OFF
April 16, 2005	2:00:00 AM	Differential Pressure LOW
April 16, 2005	4:00:00 AM	Differential Pressure OFF
April 16, 2005	5:00:00 AM	Differential Pressure LOW
April 16, 2005	7:00:00 AM	CutOff ON
April 16, 2005	9:00:00 AM	CutOff OFF
April 16, 2005	11:00:00 AM	CutOff ON

- Missing data can occur may occur when the meter is left out of service, communications problems, and battery failures.
- Meter tests. The meter should be verified or calibrated per the manufacturers specifications. Always review the "as found" and "as left" documentation on meter tests. These reports are used to document the amount or error determined by the meter inspection. This will aid in

accurately adjusting the volumes during the audit period. Review the recording ranges; are they within the flowing capacity of the meter without over ranging the device?

- Transducer-Transmitter failures. If a replacement part is not available, the meter may be placed in "manual" mode to record an average volume. This will be noted in the configuration and event logs.
- Meter zero. While a meter test may not be possible each month, zeroing the meter can reduce the risk of potential errors.
- Always request the original unedited data. This is helpful to compare to the finalized data, to establish any edits that may have taken place by the meter editor. Your check device may be used in lieu of an estimate.
- Gas quality. Differences in gas quality affect both volume and energy computations. Are the volumes recalculated at the office level? Is the gas sample historically correct?

EFM Editing

When data is imported into a measurement system, an edit may be applied to the data to complete the production month. Edits may be performed for missing data, bad meter configuration, and gas analysis updates.

Data entry errors happen at the field and office level. It is important to review the original data, to the finalized or "closed" data. If the auditor is using a measurement system, parameter changes can be performed via an EFM editing system. These recalculated results can be compared to the closed volumes. It is always a good idea to compare the results of an edit due to an incorrect orifice size, pressure base error, or gas analysis update.

Other editing errors may include:

- Importing the wrong EFM on the wrong station number.
- Deleting data; data can be accidentally purged from a system. If the data is not properly achieved, it may be lost.
- Recalculating data with an incorrect gas analysis or configuration error.
- Applying the wrong calculation method during the import process.
- Failed field device components; missed edit due transmitter failure.
- Differential pressures less than the differential pressure cutoff. In extreme cases, where the orifice size it too big, actual flow may be missed because the differential cutoff is set too high. The DP cutoff is an automatic "edit" in the device, that "zeros" out the flow below the set point.
- Time constraints. Each company has a monthly close schedule. If a questionable problem or an error is found during the editing process, there may not be enough time during "close" to research the problem. An estimate may be submitted in lieu of actual volumes.
- Lost or unreported prior period adjustments.

Primary Element Errors

The data recorded by the EFM device is only as accurate as the meter tube, (primary device). Many physical things can affect the accuracy of the volume recorded by the EFM device.

Common problems associated with primary elements include:

- Liquids; water, condensate, and oil can affect the accuracy of the measurement. In most cases, liquids within the meter run will overstate the meter zero, or indicate "false" flow.
- Leaks in piping, orifice sealing devices, or in equipment manifolds. Leaks in orifice sealing devices will generally under state the volume. A leak test should be included as part of the physical meter test.
- Plugged or damaged straightening vanes. The alignment or fastening pins may come lose over time, and slip downstream into the orifice plate holder. Typically, this will plug the upstream tap hole of a meter tube, and decrease the actual amount of differential pressure sensed across the orifice fitting.
- Orifice plate build up. Under extreme conditions, foreign material may build up in the orifice bore. When this occurs, the recorded differential becomes overstated. Salt deposits, paraffin, and treating compounds can contribute to "plug" orifice bores.
- Freezing. This is the most common problem found during cold winter months. Water and condensate can create hydrates that freeze in the primary element. Freezing can take place in the orifice bore; tap holes, sensing line, and manifolds of the measuring equipment. Always be aware of potential conditions, and observe any abrupt changes to the volumes and temperatures.
- Debris. Overtime, objects coming from surface equipment can also become lodged in the meter tube. It's always good to include a physical inspection of the primary element.

Commercial Impact

With the recent increase of gas prices, a good auditing program will insure that the gas is being measured accurately. Whether you are buying or selling the gas, an audit of the volumes is always worth the time and expense.

An "internal" audit of measured volumes helps to identify potential problems, and insure quality measurement. Human error and time constraints cannot be ruled out of the editing and auditing process. While the estimation process can be based on historical production, some times the measurement analyst must close with the best possible data available.

Current gas quality can insure that the volumes are correct. If the contract is written on a MMBTU basis, then, it behooves all parties to have a good quality sample.

Gas quality is very important, both for volumetric and energy calculations. A good practice is to be sure that the receipt points are equipped with a proportional to flow sample system. This is especially critical, if there is a big swing in the quality of the gas stream.

The overall accuracy of the system can be monitored by the system balances. Swings in the system balance, MMBTU balance, and increased fuel use could indicate potential problems in system.

Know your contract and accounting terms, too. While it is important to have a good accurate physical balance, knowing the commercial terms of the contract may help answer questions from the downstream users. Contract knowledge also helps the field technician be aware of potential problems.

Summary

EFM auditing is a necessary process in today's industry. While technology continues to improve and advance, human intervention is still part of the process. A good process and structured program can insure accurate results.