The Benefits of an Integrated Gas Measurement Process

Jayson Payne
iMeasurement Manager

The Coastal Flow Measurement Companies
P.O. Box 58965
Houston, TX 77258-8965

Introduction

According to a recent study by Pricewaterhouse-Coopers (PwC), the oil and gas industry accounts for as much as 8% of the Gross Domestic Product (GDP) in the United States and represents an impact of well over one trillion dollars annually to our economy. As the U.S. outpaces Russia and Saudi Arabia to become the world's largest producer of total petroleum and natural gas, this financial imprint will continue to grow. Does measurement matter? You bet it does! But producing monthly settlement statements for the sale and purchase of natural gas, crude oil, and other hydrocarbon fluids, in our country alone, is a monumental task. It involves the collection of massive amounts of flow data, analyses, test reports, and other information which are used in the validation and editing process. Challenging as it may be, accurate and timely hydrocarbon measurement underlies the entire financial impact that the oil and gas industry has on our economy.

Within the natural gas industry, significant progress has been made in recent years to automate the overall measurement process. The key to this improvement has been development of highly advanced electronic gas measurement software which permits seamless integration of all critical sources of measurement data, auto-validation to be accurately completed, and highly trained measurement personnel to perform error recognition and editing in a timely manner. The newest versions of such software, which incorporate the latest industry-accepted computation methods, now also allow similar automation and review/processing of measurement data for hydrocarbon liquids.

This paper will provide more insights into the component activities and benefits of an integrated gas measurement process, and explain how this approach can improve both measurement accuracy and accountability.

Components of Integrated Measurement

<u>Data Collection</u> — An integrated measurement process (as represented in Figure 1) begins with collection of the raw data produced by the measurement devices, typically utilizing a remote data retrieval (RDR) or Supervisory Control and Data Acquisition (SCADA) system. While manual data collection was once the norm, RDR or SCADA is now essential for automated polling and expediting the overall measurement process. The communication may be with a flow computer, RTU (remote terminal unit), PLC (programmable logic controller), or other device which generates or stores the measurement data. This data can then be uploaded to the integrated measurement software (IMS) for further processing.

In addition to raw flow data, it's vital that meter inspection and calibration reports, equipment change reports, and any other measurement-related reports prepared by field services be produced electronically and imported into the IMS. Fluid quality and composition (i.e., compositional analyses) should also be automatically exported from the laboratory database to the IMS to provide these critical inputs for flow data processing.

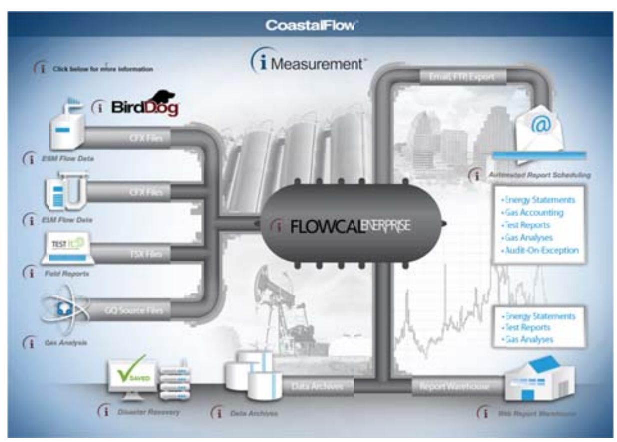

Figure 1: Graphical Depiction of Integrated Measurement

<u>Integrated Measurement Software (IMS)</u> — The heart of any fully integrated measurement system is a master database and software with comprehensive functionality, flexibility, and scalability. The primary function of integrated measurement software (IMS) is to allow all electronic gas measurement data, meter inspection and calibration reports, and laboratory gas analyses to be collected and uploaded into a centralized system for processing. Once the various data sources have been uploaded, the system should have the capability to perform flow data validation, editing, re-calculation, auto-distribution of finalized flow data, and data archiving.

The auto-validation process is usually completed within seconds, with as many as 300 validations performed on each hourly record. Some of the most common auto-validation routines and general IMS functions include:

Missing Data — Through this validation function, missing data, one of the most common sources of measurement error, is easily detected and reported daily to the measurement department as an alert to either re-poll the data or use an acceptable estimate for the missing information.

Frozen Value — This validation is a comparison of selected flowing parameters (e.g., differential pressure, pressure, temperature, volume, and energy) to prior records for identifying a disruption of a live data feed. This filter should be user-configurable for the number of repeated records, the flowing parameters to be considered, and deadband value.

Single Run — This is another user-defined validation which provides for automatic comparison of a meter's current record with prior records to identify unacceptable excess variation. The user specifies the flowing parameters to be considered; designates the comparison time frames (e.g., previous record, average, previous day's record at same time, etc.); and selects the comparisons, using percentage or standard deviation, with defined minimum or maximum differences.

Expert System — By employing statistical analysis to review historical data and identify uncharacteristic changes in a meter's data, this function provides numerous configurable set points which allow the user to customize the validation to each individual meter's flow profile.

Master Characteristics — This routine automatically inspects individual meter records to ensure that the data from the field device conforms to the measurement contract terms and base reference conditions, as well as to the volume and energy calculation variables, as applied by the user.

Gas Quality Data Analysis — Gas quality data is consolidated for validation, calculation of properties, and application to meter data. The gas quality data can originate from an online chromatograph (directly or as averaged by the flow computer), or a lab analysis of a spot or composite sample. Calculated properties include relative density, gross heating value (i.e., dry, saturated, and as-delivered), Wobbe index, component liquefiables (i.e., "GPMs" or gallons of liquefiable hydrocarbons per MCF of gas), hydrocarbon dew point, and Cricondentherm (i.e., the maximum temperature above which condensation cannot take place). Meters assigned to a gas quality data set are immediately recalculated upon receipt of new meter data or new/updated gas quality data.

Meter Inspection and Calibration Report for Validation — Test report data is electronically transmitted into the IMS central database, generally in a secure and proprietary file format. Meter characteristics are auto-validated and volume adjustments resulting from calibration errors may be performed according to contractual tolerances.

System Balancing — By constructing system balances (e.g., inlet vs. outlet comparisons) within the IMS system, identification of measurement or operational problems affecting overall LUAF (Lost and Un-Accounted For) gas volumes can be expedited. In addition, the ability to "drill down" on both a time-frame and meter-contribution basis often allows identification of the problem source(s) before initiating research in the field, saving both time and money.

<u>Closing the Measurement Process</u> — Without advanced measurement software to quickly and accurately process massive amounts of data each month, the questionable integrity of data used for gas purchases and sales would create uncertainty throughout the entire industry. The data that the measurement industry produces has a bottom-line effect on royalty payments, sales, cash flow, productivity, performance, reservoir engineering, as well as regulatory and contractual compliance.

Equally essential to the integrated measurement process are the measurement professionals who are responsible for managing this advanced operation. This includes reviewing the exceptions which are automatically flagged, identifying/resolving problems not flagged by the system, approving/applying any necessary corrections, performing edits, effectively communicating with field and office personnel, scheduling the distribution of finalized data to the gas accounting department and authorized third-parties…and doing all of this within very tight timeframes.

Table 1 lists some of the most common sources of orifice measurement error, yet these represent only a portion of the more than 50 typically identified error sources. Highly trained and experienced measurement analysts must detect and correct these myriad error sources…and all before the 5th working day of each month for custody transfer measurement.

Table 1: Common Sources of Orifice Measurement Error

Rank	Top 10 Sources of Error	%
1	Orifice Sizing	25.60
2	Analytical Data	21.13
3	Liquids in the Meter	9.78
4	Reported Wrong Volume	8.45
5	Compressor-Generated Pulsation	5.95
6	Set-Up Factors	5.50
7	Incorrect Estimate/Edit	5.21
8	Calculation Method	4.77
9	Meter-Out-of-Service	4.72
10	Defective Transducer	3.29

These errors:

- Were the top 10 causes of an unacceptable difference between a check meter and sales meter resulting in 2,035 audits between 2003 and 2011;
- Involved 26 producer and pipeline measurement departments; and
- Are ranked in order according to the percent of audits in which these problems were the primary source of the difference.

<u>Automated Report Scheduling</u> — Once measurement data has been closed for the month, a report scheduler should provide standard/custom exports and/or reports created and distributed on a user-specified interval (e.g., daily, weekly, or monthly options). The distribution mediums should include, at a minimum, fax, email, FTP, or web posting. By making this data available in a file format compatible for auto-import into gas accounting, regulatory, or other approved departmental systems, errors associated with transposition are eliminated, there's a greater level of assurance that data integrity has been maintained, and the overall process is expedited.

<u>Data Archiving</u> — Electronic Gas Measurement (EGM) data should be archived according to API Chapter 21 Audit Trail requirements, thereby providing assurance that flow data is stored in compliance with recommended industry standards in the event of an audit. Records are typically stored for a minimum of 7 years.

<u>Web-Based File Storage & Access</u> — Through flexible Internet-based access to current and historical report data (including volume statements laboratory analyses, and meter inspection and calibration reports), a web-based file storage system offers a simple, secure means for sharing information with coworkers and entitled third-parties, while providing another resource for business continuity and disaster recovery.

<u>Disaster Recovery</u> — In order to preserve the integrity of an integrated gas measurement process, it's critical that a broad Disaster Recovery and Business Continuity (DR/BC) plan is in place, up to date, and fully functional. This assures that reliable alternate processes or resources may be substituted in the event of an emergency or natural disaster (e.g., fire, hurricane, power outage, flood, tornado, etc.). DR/BC systems should be fully synchronized with the exact software versions, service packs, and patches used in existing production servers, and comprehensive disaster recovery testing should be conducted multiple times every year. DR/BC resources should be designed to protect critical data while ensuring minimal systems downtime, even in the event of a major outage.

Benefits of Integrated Measurement

There are many broad and potentially significant benefits to be gained from use of a fully integrated measurement system, including the following:

Faster Data Collection & Processing — Companies not using a centralized measurement system may need to wait several days or longer to enter data into their existing measurement system due to a disruption or delay in delivery of physical records, technicians failing to collect and submit data in a timely fashion, or other problems in a manually-intensive process. The integrated, automated process eliminates these time delays.

Flagging/Correcting Suspect or Missing Data — An integrated measurement system can identify suspect and missing data and often can automatically apply the appropriate corrections, thereby allowing an analyst more time to *resolve* data problems rather than *search* for them.

Ready Access to Field Test Reports — Another benefit to a fully integrated measurement process is the ability to import field test reports directly into the system so that these may be readily checked against the existing measurement data for discrepancies and calibration errors.

Integration of Laboratory Analytical Results — When laboratory analytical data can be automatically applied to the correct meter station, this eliminates the need to hand-enter an analysis for each meter while accelerating overall processing time and minimizing data entry errors.

Automatic Data Archiving — With a comprehensive integrated measurement system, all data is automatically archived and readily accessible for retrieval at any time, whether for routine requirements or disaster recovery and business continuity purposes. Web-based access further enhances the flexibility and timeliness of data retrieval.

Advanced Research & Troubleshooting Tools — A class-leading, fully-integrated measurement system will allow analysts to search for, identify, and solve common sources of measurement errors, such as orifice sizing discrepancies, meter freeze, liquids in meters, missing set-up factors, and meters out-of-service, just to name a few. It also allows the analyst to search for LUAF quantities of gas. By utilizing an integrated measurement system, a single analyst can manage more than one thousand electronic gas measurement meters; historically, a team of analysts was required to handle the same number of meters.

Consolidated Measurement Database — Perhaps the greatest benefit from a centralized and fully integrated measurement system is that all measurement data can be managed within a single database for the accurate, efficient preparation and distribution of finalized volume statements and supporting documentation.

Conclusions

Measurement, as it has been for decades, is the cash register for today's energy companies. Through advances in technology which allow fully integrated measurement systems and processes to be utilized, the bottom-line benefits for a company are significant. The savings that can be realized through an integrated system include less time spent by individual analysts searching for measurement problems, the automatic validation and correction of measurement data, the need for less staffing, and the ability to have all data managed, archived, and accessible through a single source. This technology effectively and efficiently reduces costs which, of course, should be a fundamental goal for every company.

References

American Gas Association, *History of Gas Measurement*, A.G.A. Gas Measurement Manual, Part One, Section 1.1, p. 1-12.

Fillman, M. B. and Payne, J. A., *Upstream Natural Gas Sales Verification*, Corpus Christi Area Measurement Society, 2013.

Anerousis, J. P., et al, *An Updated Examination of Web-Based Solutions for Orifice Measurement and Monitoring*, The Coastal Flow Measurement Companies, 2012.

Menzel, G. P. and Squyres, R. M., *Electronic Gas Measurement Audit*, Acadiana Flow Measurement Society, 18th Annual Measurement Short Course, 1997.

Menzel, G. P., *Interview on Common Sources of Orifice Measurement Error*, The Coastal Flow Measurement Companies, February 5, 2013.