HOST GAS MEASUREMENT AUDIT TRAIL DATA HANDLING AND MAINTENANCE TECHNIQUES
Class # 3200

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Introduction

Host Gas Measurement Systems are a requirement in today's business for any company involved in the production, gathering, distribution, transmission or processing of natural gas. In this paper, we will discuss what a Host Gas Measurement System is, what it does and the requirements. We will also discuss some of the maintenance issues around the ever expanding requirements for measurement data, how this is handled in the real world and the reporting requirements for the data. And finally, we will talk about some example applications that are available on the market today.

What is a Host Gas Measurement System?

Host Gas Measurement Systems have traditionally been defined as software applications that allow users and businesses to manage the huge amounts of Electronic Flow Meter (EFM) audit trail data as well as the management, corrections, re-calculations and reporting of that data all in compliance with all regulations and standards.

More simply: a software application that:

- Stores large amounts of EFM data for a long period of time; usually one year or more,
- Allows for data corrections and re-calculations,
- Facilitates analysis of the data,
- Allows exporting and Reporting of the data,
- Facilitates automation of every aspect,
- All in compliance with regulations and standards.

Many businesses have tens of thousands of EFMs and most have EFMs from many different manufacturers. Also, the regulations for measurement systems are getting stricter and require more data. This all leads to the fact that now, more than ever, businesses have an ever increasing maintenance problem.

Furthermore, with the increased need to move the audit trail data into the host system, more and more businesses are requiring that Gas Measurement Systems also include pre-integrated data gathering systems. Without a pre-integrated data gathering solution, companies may spend hundreds of thousands of dollars to initially get the Measurement System configured and running properly, delivering valid and quality reports.

Old and New Data Requirements

The typical data requirements for a Host Gas Measurement System in the United States are based on API Standard 21.1. That is Chapter 21, 'Flow Measurement Using Electronic Metering Systems', Section 1, 'Electronic Gas Measurement', from the American Petroleum Institute. This is a voluntary standard, accepted by the Gas Industry as a standard that defines the Electronic Measurement Systems algorithms, installations, calibrations, verifications, reporting requirements and security. It also references American Gas Association (AGA) Report numbers 3, 5, 7, 8, and more, that cover gas energy calculations including volumetric calculations of differential and linear meters as well as the compressibility of gas.

Audit trail data includes daily and hourly volume data, events, alarms, gas analysis, and meter configuration (characteristics) data. Basically, all data that is required or affects the re-calculation of volumes in the case of an error that has occurred in the data, or there is a problem with the meter.

The components of the audit trail are:

- **Daily/Hourly data** – Meter ID, Date, Time, Volume, Flowing Time, Avg. Temp, Pressure, Diff. Pressure, Rel. Density, Energy, Extension,
- **Events** – Date and Time of event, Old Value, New Value, Event Text,

- **Alarms** – Date and Time of alarm, Trigger Point, Status, Alarm Text,
- **Gas Analysis** – Date/Time Start, Date/Time End, BTU, Viscosity, Heat Ratio, and gas composition, and
- **Meter Characteristics (Configuration)** – Date/Time Start, Date/Time End, All configuration parameters that would affect the calculation of the flow including but not limited to: Orifice diameter, Pipe diameter, tap type, tap location, atmospheric and pressure bases, calculation methods, etc.

Some additions have been made to the data requirements for the API 21.1 Standard in 2010. There have been at least 28 additional items added for differential meters and 28 additional items added for linear meters, as well as some overall changes. Most of the detailed changes are additional information about the configuration of the meter such as:

- Software/Firmware version,
- Beta/Area ratio,
- Reference temperatures for the orifice and pipe,
- Discharge coefficients and anything affecting this like slope factors or offsets,
- BTU content (if not live),
- Gas expansion factors,
- Quantity calculation periods (flow time),
- Sampling rate,
- Meter elevations,
- Absolute viscosity,
- All alarm setpoints - highs, lows of Static Pressure, Diff. Pressure and Flowing Temperature,
- Mass flow parameters,
- No-flow cutoff values, and
- Many more.

There are also some overall changes that the standard requires for audits and records:

- Average Extension for all Hourly and Daily Quantity Transaction Records (QTR),
- All Hourly and Daily data must be stored is non-rounded floating-point format,
- Methodologies for editing of the QTR, or Hourly/Daily original records,
- Defined and required use of the Flow Dependant Linear Average Method to calculate average of Differential Pressure, Static Pressure, and Flowing Temperature. This was not required before.

There is also a ‘Grand-Father’ clause in the document excluding all prior installations.

When it is understood that most flow computers hold at least thirty-five days worth of hourly and daily data for each meter run—which is eight-hundred forty hourly records and thirty-five daily records plus all of the alarms, events, gas analysis, and meter configuration, then the realization takes place that this is a lot of data. Not only is this a lot of data, but also there are dozens of criteria that need to be applied to this data to make a determination that this data is valid and of good quality.

Maintenance Issues and Requirements

Maintenance of any enterprise software package must be considered when purchasing any Host Measurement System. With the possible amounts of data, as well as the expectation of most companies to keep at least one year of data online, maintenance can be significant. Also, without a measurement system that has enough features to handle the automation of the tasks involved, the maintenance issues can be even greater.

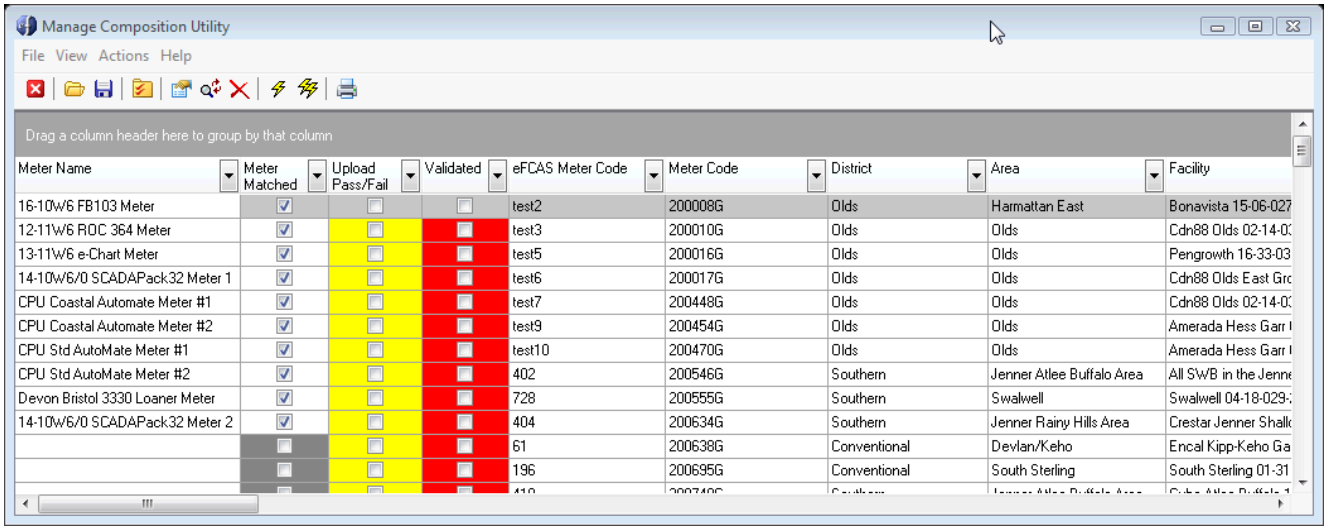
Some of the things that need to be considered:

- Cost of the supporting systems, like MS SQL Server, Oracle Enterprise, Reporting, etc.
- Cost of upgrades and patches. How hard is it to patch the entire system, etc.
- Size of the database and hardware. If the host system pulls extraneous data, then the size of the database can grow at abnormal rates and create a need for more expensive hardware, larger hardware, and more.
- How hard is it to trim old data out of the system?
- Database backups. Are they automated within the system or is the IT department required to implement this function.

- Addition of new meters into the system. How much work is it? How long will it take? What level of resource is required to add meters to the system?
- How difficult is it for an administrator to edit a report, or the name of a meter, etc?
- How much time will it take to change the polling intervals on the retrieval of the data?
- What is the cost of maintenance and support each year?
- How long does it take to get bug fixes, or new features implemented?

Another huge maintenance issue is not with the Host System, but managing gas and liquid compositions of meters in the field that do not have on-line analyzers/chromatographs. Usually, product samples are required to be taken and analyzed every. Once the data is analyzed, the new data then needs to be put into the EFM such that calculations are true and accurate, based on the new gas analysis.

Some host systems keep records of what the composition of the product is supposed to be, checks whether this is correct, and if not, it flags the data as a possible issue.



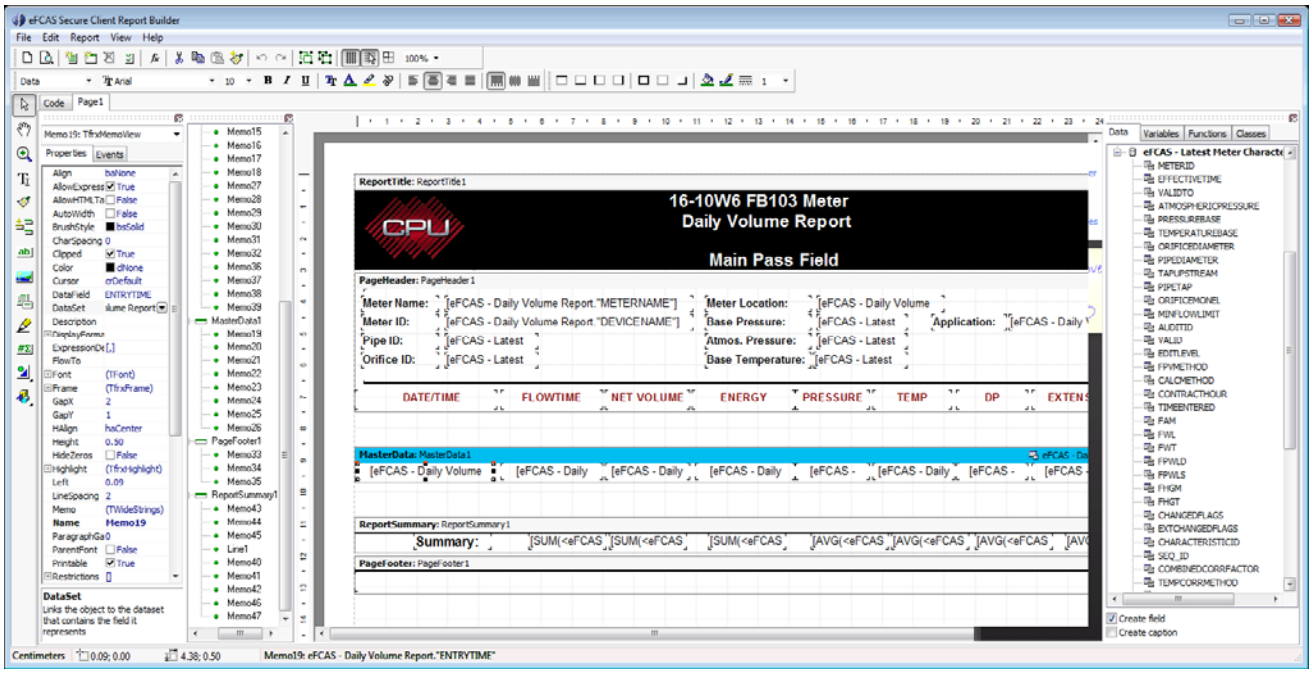
But the real savings comes when the compositions are updated, if the system lets you easily update the composition, then writes the new composition to the EFM, and then confirms that the data was written successfully.

The bottom line is that the amount of maintenance of the Host Measurement System directly affects the businesses' actual bottom line, and all of the above items plus more can cost a business hundreds of thousands of dollars a year, if not considered in the overall cost of a solution. Thus, it is far more important to look at the recurring costs of a Gas Measurement System than the initial costs.

Reporting

Reporting is one of the most important features of the Host Gas Measurement System. You cannot have good reports without good data, and the right data. The data must be high quality and structured such that all of the pertinent data required for a report is available in a 'reasonable' amount of time when the report is generated.

A good solution should come with standard, canned reports right out of the box and the ability for a user, with the right security, to edit the reports any time necessary.



Not only are ‘regular/normal’ reports required like:

- Hourly Volume Statements,
- Daily Volume Statements,
- Alarm Reports,
- Event Reports,
- Audit Reports, and
- End-of-Month Reports.

Daily Volume Report

Main Pass Field

Meter Name: Meter
Meter ID: Meter
Pipe ID: 1.949
Orifice ID: 0.625

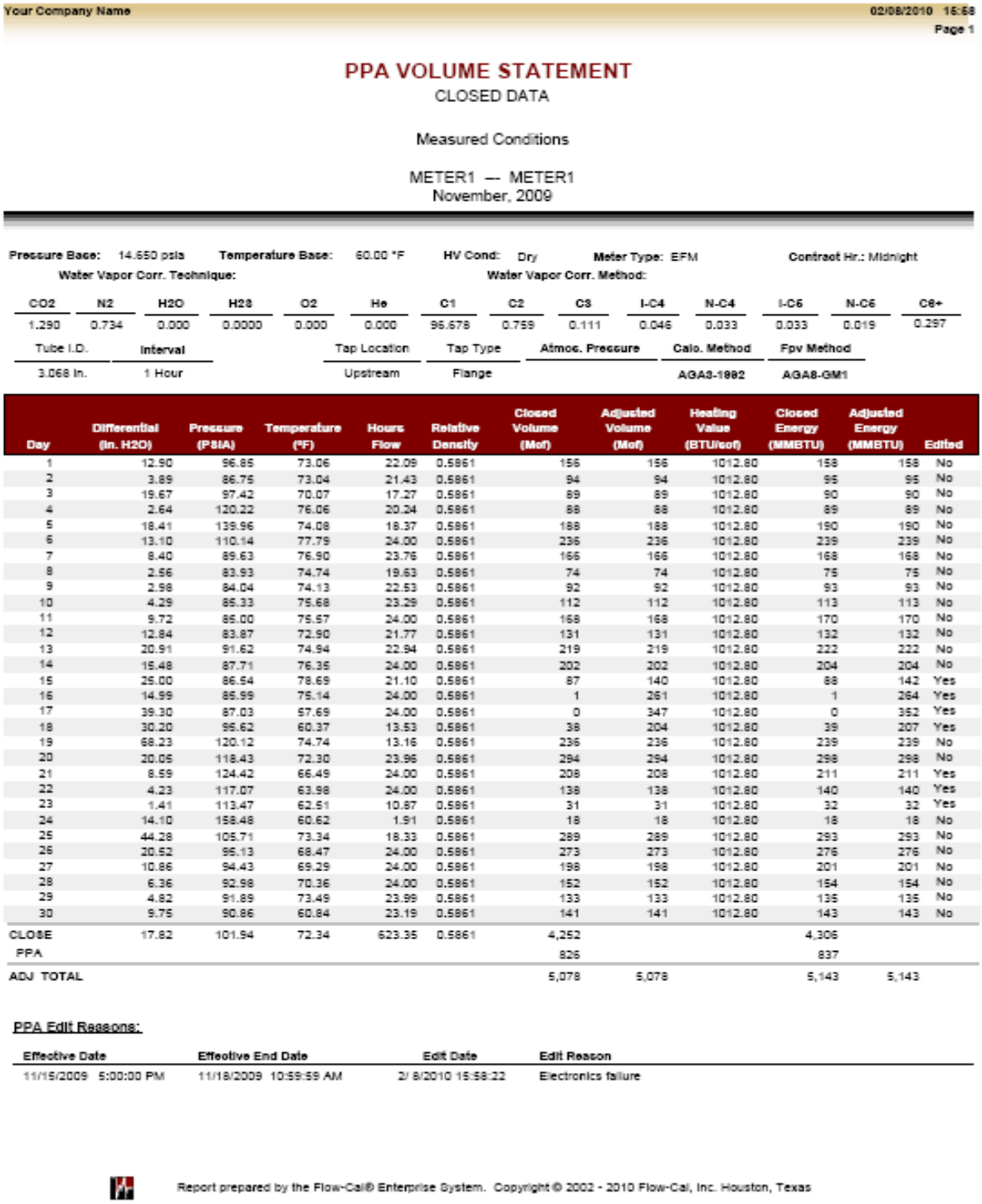
Meter Location: Main Pass
Base Pressure: 14.700
Atmos. Pressure: 15.025
Base Temperature: 60.000

Application: Natural Gas

DATE/TIME	FLOWTIME	NET VOLUME	ENERGY	PRESSURE	TEMP	DP	EXTENSION
12/01/2010 05:00:00	24.000	372.200	404.900	1113.000	64.00	17.200	139.300
12/02/2010 05:00:00	24.000	325.600	354.300	1115.000	67.00	13.300	122.400
12/03/2010 05:00:00	23.970	313.000	340.600	1111.000	70.00	12.400	118.300
12/04/2010 05:00:00	24.000	318.400	346.400	1108.000	70.00	12.900	120.400
12/05/2010 05:00:00	23.980	302.500	329.100	1109.000	62.00	11.300	112.800
12/06/2010 05:00:00	23.420	320.700	348.900	1107.000	58.00	13.300	119.000
12/07/2010 05:00:00	24.000	313.500	341.100	1112.000	61.00	12.100	116.600
12/08/2010 05:00:00	23.750	246.300	268.000	1103.000	55.00	7.500	91.100
12/09/2010 05:00:00	23.500	226.200	246.100	1120.000	59.00	6.400	83.900
12/10/2010 05:00:00	24.000	292.500	318.200	1120.000	63.00	10.500	109.100
12/11/2010 05:00:00	23.980	337.600	367.400	1114.000	64.00	14.100	126.200
12/12/2010 05:00:00	23.990	268.000	291.500	1123.000	54.00	8.600	98.700
12/13/2010 05:00:00	23.980	200.300	217.900	1111.000	41.00	4.600	71.500
12/14/2010 05:00:00	24.000	81.900	89.100	900.000	49.00	1.000	30.200
12/15/2010 05:00:00	24.000	68.100	74.100	845.000	60.00	0.800	25.800
12/16/2010 05:00:00	24.000	62.600	68.200	634.000	67.00	0.900	24.400
12/17/2010 05:00:00	24.000	49.000	53.200	519.000	59.00	0.700	19.000
12/18/2010 05:00:00	23.030	47.200	51.400	515.000	52.00	0.700	18.200
12/19/2010 05:00:00	24.000	29.500	32.100	180.000	57.00	0.700	11.600
12/20/2010 05:00:00	24.000	10.900	11.900	15.000	63.00	0.700	4.400

But there are also special reports like:

- Prior Period Adjustments, or PPA,
- Multiple meter reports, and
- Graphs and charts to visualize information like total production of a field, downtime, etc.



Your Company Name 02/08/2010 15:58
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PPA VOLUME STATEMENT

CLOSED DATA

Measured Conditions

METER1 — METER1
November, 2009

Pressure Base: 14.650 psia Temperature Base: 60.00 °F HV Cond: Dry Meter Type: EFM Contract Hr.: Midnight
Water Vapor Corr. Technique: Water Vapor Corr. Method:

CO2	N2	H2O	H2S	O2	He	C1	C2	C3	I-C4	N-C4	I-C5	N-C5	C6+
1.290	0.734	0.000	0.0000	0.000	0.000	96.678	0.759	0.111	0.046	0.033	0.033	0.019	0.297

Tube I.D.	Interval	Tap Location	Tap Type	Atmos. Pressure	Calc. Method	Fpv Method
3.068 in.	1 Hour	Upstream	Flange		AGA3-1992	AGA8-GM1

Day	Differential (in. H2O)	Pressure (PSIA)	Temperature (°F)	Hours Flow	Relative Density	Closed Volume (Mcf)	Adjusted Volume (Mcf)	Heating Value (BTU/scf)	Closed Energy (MMBTU)	Adjusted Energy (MMBTU)	Edited
1	12.90	96.85	73.06	22.09	0.5861	156	156	1012.80	158	158	No
2	3.89	86.75	73.04	21.43	0.5861	94	94	1012.80	95	95	No
3	19.67	97.42	70.07	17.27	0.5861	89	89	1012.80	90	90	No
4	2.64	120.22	76.06	20.24	0.5861	88	88	1012.80	89	89	No
5	18.41	139.96	74.08	18.37	0.5861	188	188	1012.80	190	190	No
6	13.10	110.14	77.79	24.00	0.5861	236	236	1012.80	239	239	No
7	8.40	89.63	76.90	23.76	0.5861	166	166	1012.80	168	168	No
8	2.56	83.93	74.74	19.63	0.5861	74	74	1012.80	75	75	No
9	2.98	84.04	74.13	22.53	0.5861	92	92	1012.80	93	93	No
10	4.29	85.33	75.68	23.29	0.5861	112	112	1012.80	113	113	No
11	9.72	85.00	75.57	24.00	0.5861	168	168	1012.80	170	170	No
12	12.84	83.87	72.90	21.77	0.5861	131	131	1012.80	132	132	No
13	20.91	91.62	74.94	22.94	0.5861	219	219	1012.80	222	222	No
14	15.48	87.71	76.35	24.00	0.5861	202	202	1012.80	204	204	No
15	25.00	86.54	78.69	21.10	0.5861	87	140	1012.80	88	142	Yes
16	14.99	85.99	75.14	24.00	0.5861	1	261	1012.80	1	264	Yes
17	39.30	87.03	67.69	24.00	0.5861	0	347	1012.80	0	352	Yes
18	30.20	95.62	60.37	13.53	0.5861	38	204	1012.80	39	207	Yes
19	68.23	120.12	74.74	13.16	0.5861	236	236	1012.80	239	239	No
20	20.05	118.43	72.30	23.96	0.5861	294	294	1012.80	298	298	No
21	8.59	124.42	66.49	24.00	0.5861	208	208	1012.80	211	211	Yes
22	4.23	117.07	63.98	24.00	0.5861	138	138	1012.80	140	140	Yes
23	1.41	113.47	62.51	10.87	0.5861	31	31	1012.80	32	32	Yes
24	14.10	158.48	60.62	1.91	0.5861	18	18	1012.80	18	18	No
25	44.28	105.71	73.34	18.33	0.5861	289	289	1012.80	293	293	No
26	20.52	96.13	68.47	24.00	0.5861	273	273	1012.80	276	276	No
27	10.86	94.43	69.29	24.00	0.5861	198	198	1012.80	201	201	No
28	6.36	92.98	70.36	24.00	0.5861	152	152	1012.80	154	154	No
29	4.82	91.89	73.49	23.99	0.5861	133	133	1012.80	135	135	No
30	9.75	90.86	60.84	23.19	0.5861	141	141	1012.80	143	143	No
CLOSE	17.82	101.94	72.34	623.35	0.5861	4,252			4,306		
PPA						826			837		
ADJ TOTAL						5,078	5,078		5,143	5,143	

PPA Edit Reasons:

Effective Date	Effective End Date	Edit Date	Edit Reason
11/15/2009 5:00:00 PM	11/18/2009 10:59:59 AM	2/ 8/2010 15:58:22	Electronics failure

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Because the Host Gas Measurement System holds so much data, many enterprise systems within the company usually need this data from the system in one form or another. Automated scheduling of either report formed exports, database linked exports, or some other form of data transfer is a normal mode of operation.

Available Solutions Today

Many customers use multiple applications from vendors to meet the rigorous requirements of a Host Gas Measurement System. Some vendors provide part of the system, but their solution may not meet all of the requirements of an enterprise solution. Thus, businesses might use one vendor to get the data, another to host and process the data, and yet another to export the data. In today's market, this type of solution is no longer a requirement because there are solutions available that both gather and perform the other operations of Host Gas Measurement System with little or no integration.

Furthermore, some of the EFM vendors have software that can be used to pull audit trails from their meters but usually not from other vendors' meters. So, the companies end up with multiple HMIs from different vendors that ends up being hard to handle and difficult to manage. They also usually just dump data to a file or report that the user then has to send via e-mail or some other media to Production Accounting, which is really not the most ideal solution for anyone with more than about two dozen meters. There are other issues with multiple HMIs including the requirement to have resources that are experts on all of the different HMIs, having to know how to use them and how to connect to each device to download audit trail data.

Some of the vendor solutions of Enterprise Host Gas Measurement Systems are:

- Flow-Cal
- Quorum - PGAS
- CPU - eFCAS

All of the systems above allow for the importing of data along with some analysis the data. Not all of them gather their own data, but companies can use a multi-vendor solution from one of the vendors below to get their data if necessary.

Some of the Audit Trail and Data Collection Systems are:

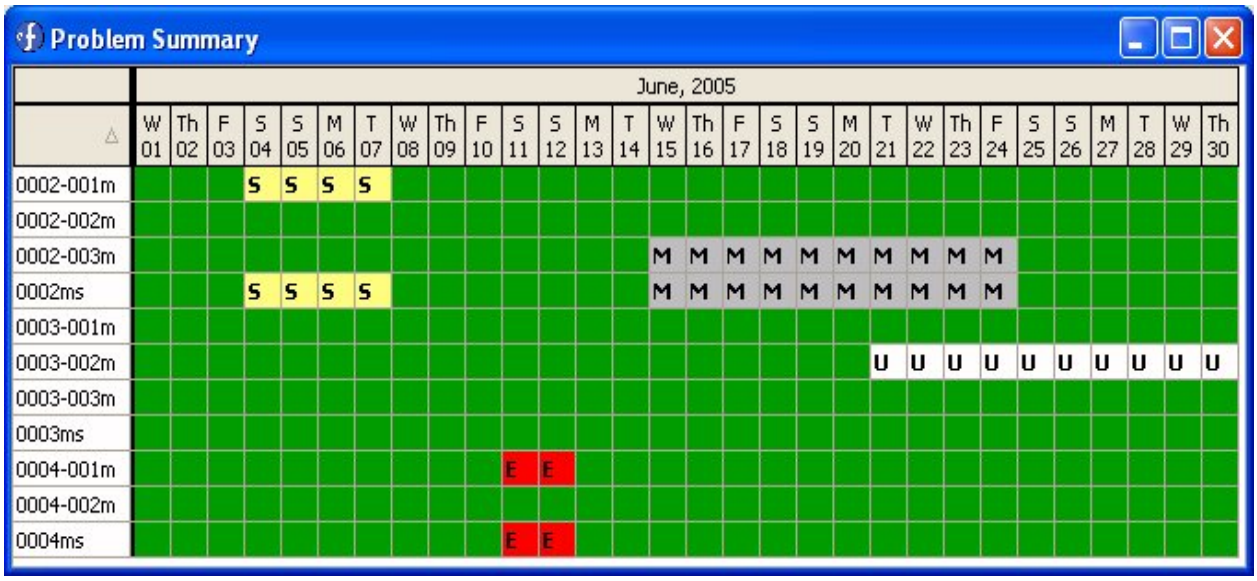
- AutoSols' AES
- CPUs' eFCAS EFM Management Software
- KepWare OPC Server and drivers for each protocol

The above systems can get real-time data as well as the full Audit Trial in some cases. The differentiator in the systems is how easy is it to integrate the resulting data into the Host Gas Measurement System. In some cases the data is pre-integrated into the system, and in some cases, data must be put into a database or a file and then imported into the Host Measurement System.

Automation

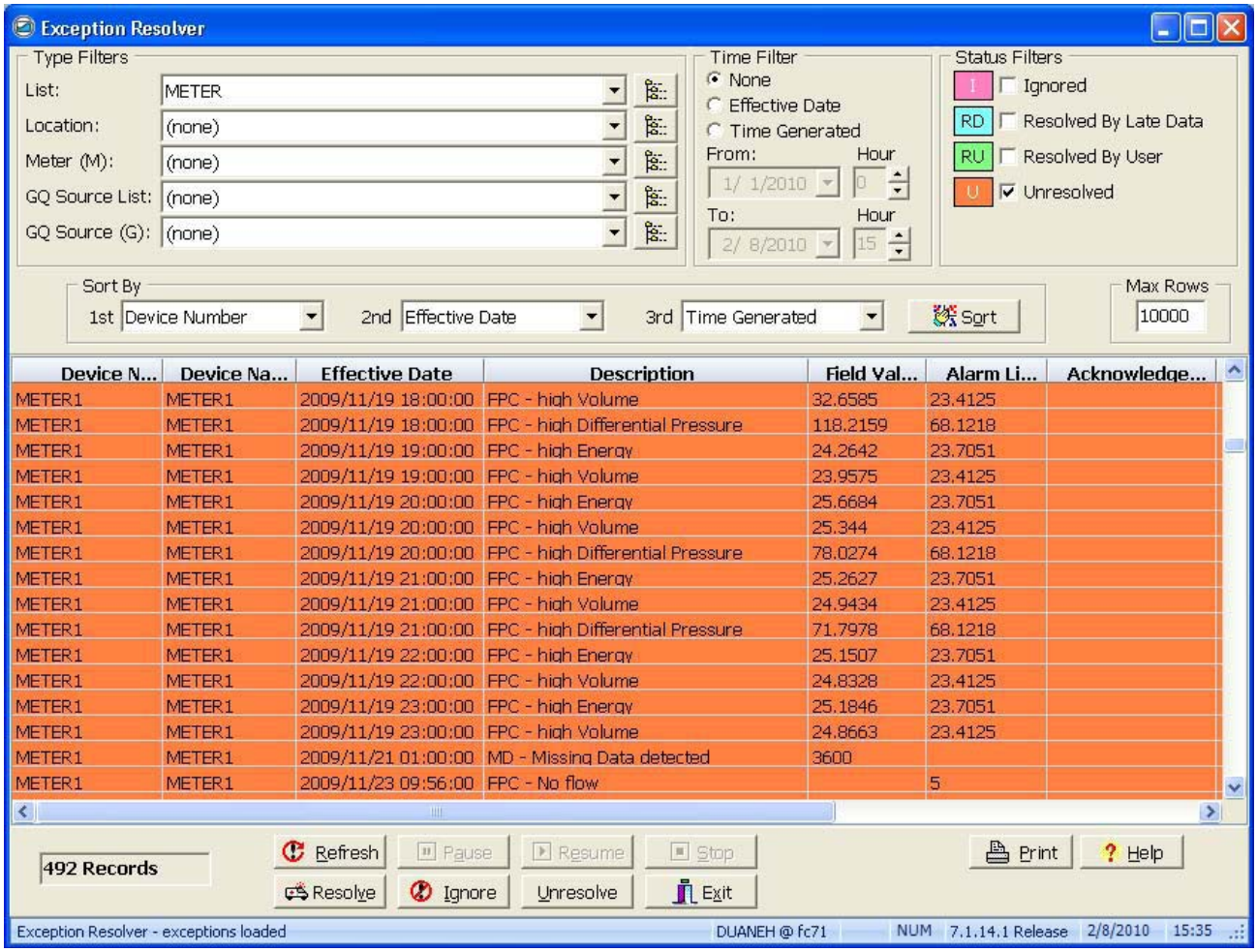
Due to the fact that many businesses have so many EFMs, automating every aspect of a Host Measurement System can greatly reduce the cost of installation, configuration, maintenance and reporting of the data. Some systems today have greatly reduced the configuration costs of setting up the initial system as well as adding in a new EFM. Furthermore, they can also automate the collection, validation, reporting, and even the maintenance within the measurement system to greatly reduce the cost of maintenance.

For instance, eFCAS will automatically import the data directly from the meter and validate the data as it comes in flagging the data if configured to do so. The results of this automatic analysis can be seen in the Problem Summary which shows if any data is Suspect (S), Missing (M), in Error (E), not collected yet (U), or OK.



There is also a view that shows only things that are exceptions and leaves out the good data. All of these are helpful when identifying issues with thousands of meters.

Flow-Cal has a similar screen but allows users to choose how they want to handle the exception after the exception occurs as seen in their Exception Resolver.



In the Enterprise version of Flow-Cal as well as in all versions of eFCAS, users can configure reports to be generated automatically and delivered to a website or to their e-mail. This is a significant time-saving feature where the analyst can review the data to ensure its accuracy once the report is complete. If the report has a problem, then the analyst can go to the system to identify and rectify the issue.

All of these features, the automated data collection, exception identification and resolution, along with automated reports and exports allow business professionals to add more value to their company's day-to-day operations, rather than spending their valuable time performing detailed analysis that should be done by the Host Measurement System.

Conclusion

Resulting Enterprise Host Gas Measurement Systems can handle terabytes of data every year. The analysis, validation, corrections, and reporting of this data can be a daunting task for company resources, if not properly managed. Having the right solution for your company is critical to the success of the Measurement team. If the right system is selected, and the proper configurations of automation for Audit Trail Collections, validation and reporting are put into place, then the maintenance and handling of the huge amount of measurement data can be minimized, and the company profits can be maximized.