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INDUSTRY, CRT-SERVICES
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DIGITAL RESOURCES.

MisMeasurement Management



What is MisMeasurement Management (MMM)?

Mis`meas´ure`ment

n. 1. Wrong measurement.

Webster's Revised Unabridged Dictionary, published 1913 by C. & G. Merriam Co.

What is MisMeasurement Management (MMM)?

It is NOT about UNCERTAINTY

DAILY REPORT			
Date : 01/31/12		Time : 00:00:00	
DAILY VALUES			
Daily Gross Total	MACF		5319
Daily NET Total	MSCF		122822
Daily MASS Total	Klb		5878
Daily Energy Total	MMBTU		131626
Net Delivery Time	hh:mm		24: 0
Cum. Net Open	MSCF		180774148
Cum. Net Close	MSCF		180896971
Cum. Energy Open	MMBTU		193260466
Cum. Energy close	MMBTU		193392092
DAILY AVERAGES			
Orifice Bore	TN		10.0

$U_{95\%} = 1.0\%$
→ 95% chance that the invoice is in error by **no more** than 1228 MSCF in either direction

What is MisMeasurement Management (MMM) ?

It is about **CERTAIN** errors

```

DAILY REPORT
Date : 01/31/12   Time : 00:00:00

DAILY VALUES

Daily Gross Total   MACF           5319
Daily NET Total     MSCF           122822
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Net Delivery Time   hh:mm           24: 0

Cum. Net Open       MSCF          180774149
Cum. Net Close      MSCF          180896971
Cum. Energy Open    MMBTU          193260466
Cum. Energy close   MMBTU          193392092

DAILY AVERAGES

Orifice Bore       TN           10.0
  
```

Measurement error of
+ 1.0%
→ It is **CERTAIN** that
the invoice is **1228**
MSCF
TOO HIGH

Error Detection

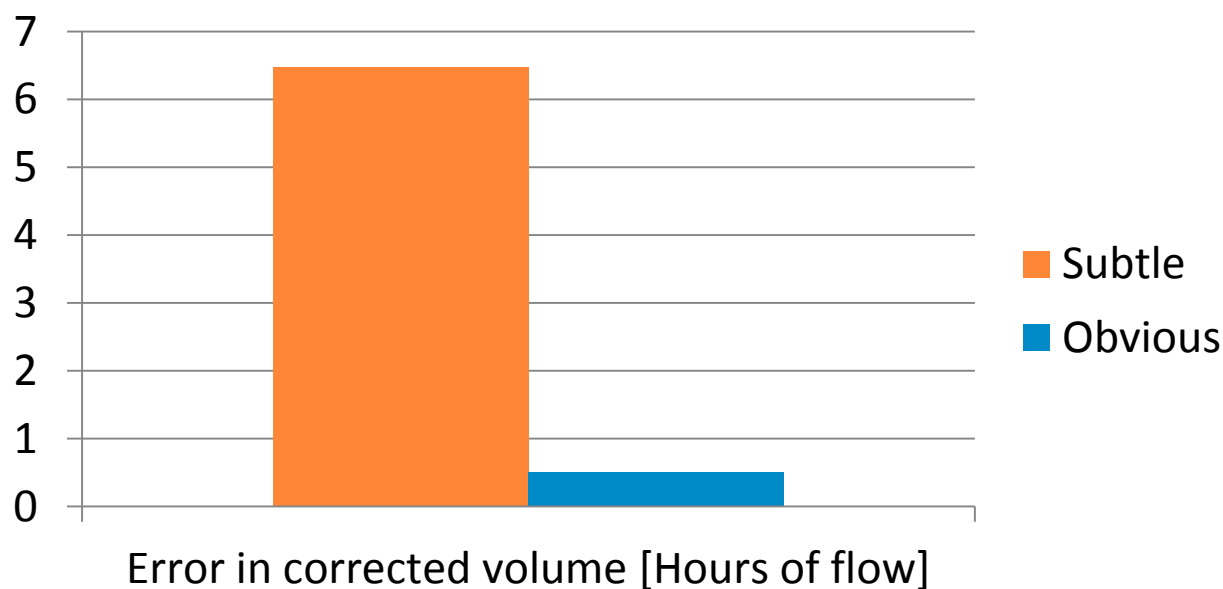
Isn't that already taken care of?



Obvious vs. subtle errors – Example Gas

Flow meter failure for 30 minutes

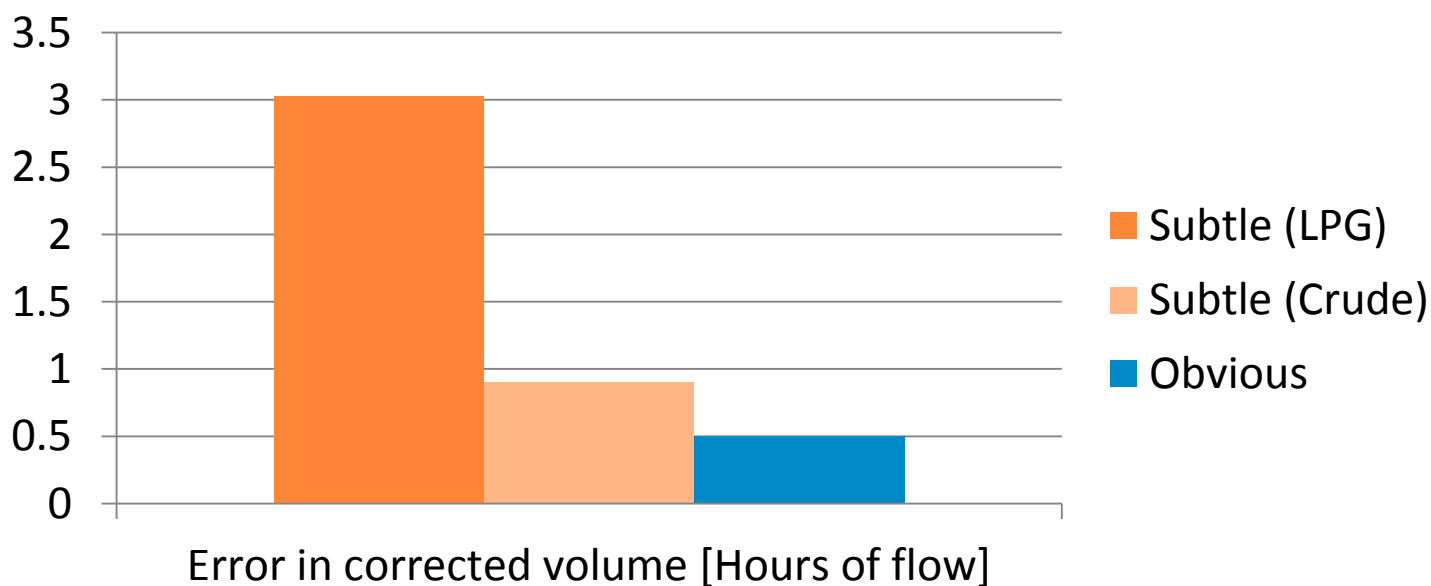
Meter pressure 0.3 % bias for 3 months



Obvious vs. subtle errors – Example Liquid

Flow meter failure for 30 minutes

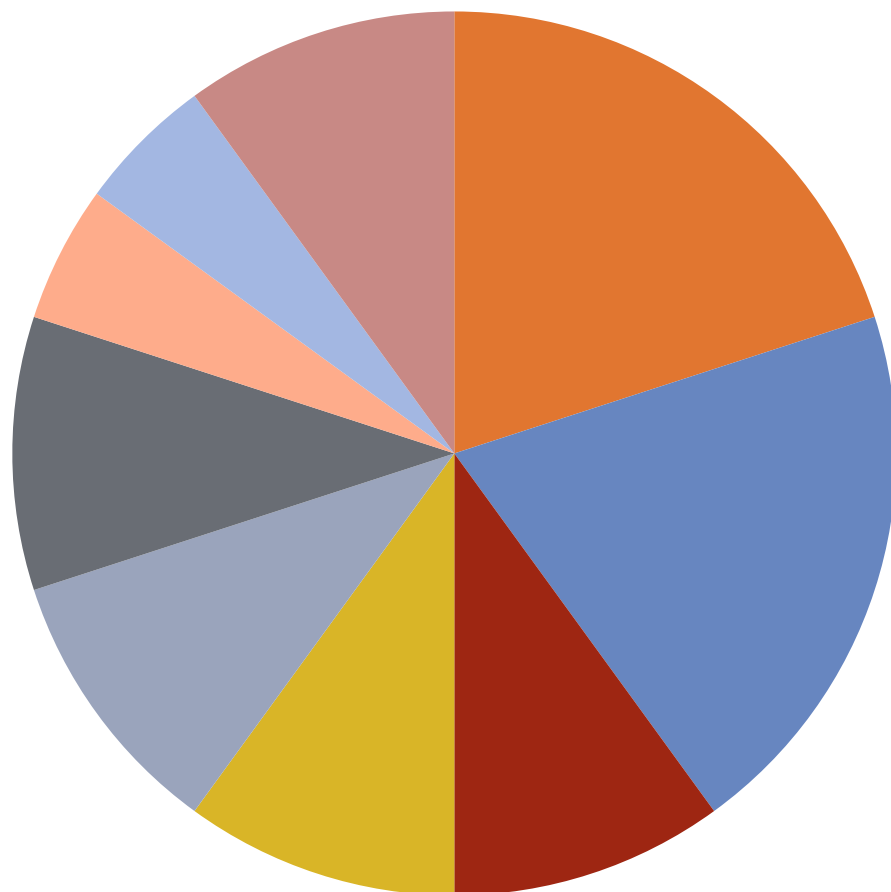
Prover temperature 0.5 °C bias for 3 months



Subtle errors

Gas orifice measurement USA 2003 - 2011

Failures **only** discovered during audits



- Orifice plate
- Analytical data
- Out of calibration
- Manual data entry
- Liquids
- Setup & calculations
- Meter freeze
- Pulsating flow
- Other

Source: Compiled from several papers presented at the ISHM

Subtle errors

Examples from UK sector 2010

Errors requiring correction (> 0.1 % on daily basis)

Fault	Duration	Error [1000 Euro]
Turbine HF fail	15.5 hours	7
Both DPs and P failed validation	5 months	17
Double drain hole correction	40 days	6
High dP out of calibration	5.5 months	60
GC failure (cleared automatically)	3 hours	27
Pressure transmitter lock-up	2 hours	30
Low dP failed validation	9 months	20
GC not commissioned correctly	15 months	110

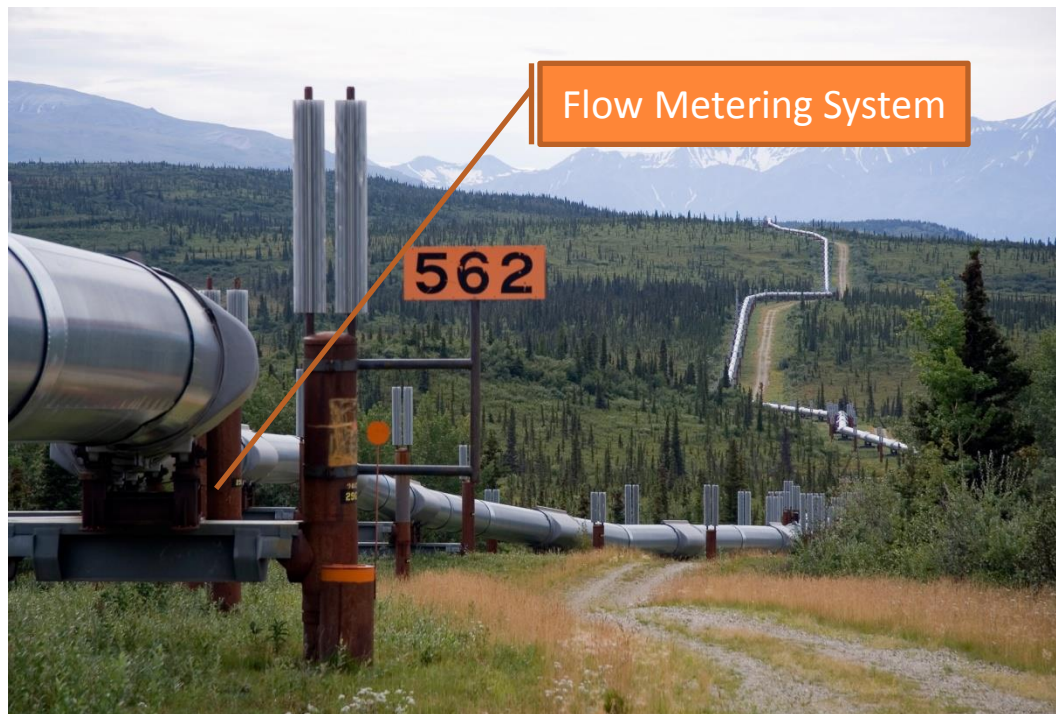
Source: UK Gas Governance web site

When is MMM important?



3 independent opinions

When is MMM important?



1 opinion only

Subtle errors

Ambient temperature influence **Leaks** Ice formation **Plugged** impulse lines Disturbed flow profile Transmitter **drift** and **shift** Blockage Debris Wear Corrosion Damage **Pulsating flow** Solids Proving problems **Out of range** Calibration errors **2 phases** (gas in liquid, liquid in gas) **TYPOS** Non-compliance with measurement standards and vendor recommendations (Installation, Geometry, Fluid properties, Calculation boundaries) **Wrong configuration settings**

Subtle Error Detection

Methods in order of preference

2nd opinion

Diagnostics

Proving / Calibration

Audits

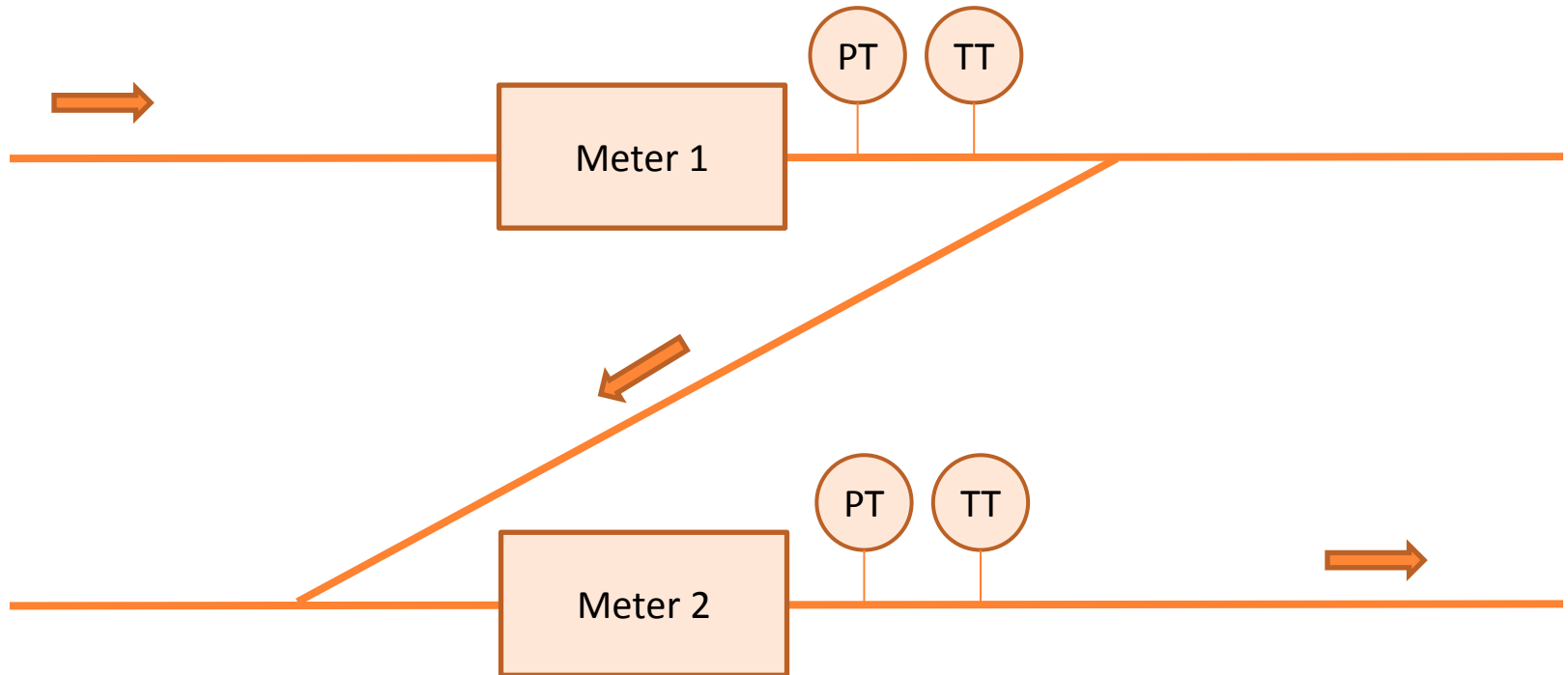
Accounting Systems



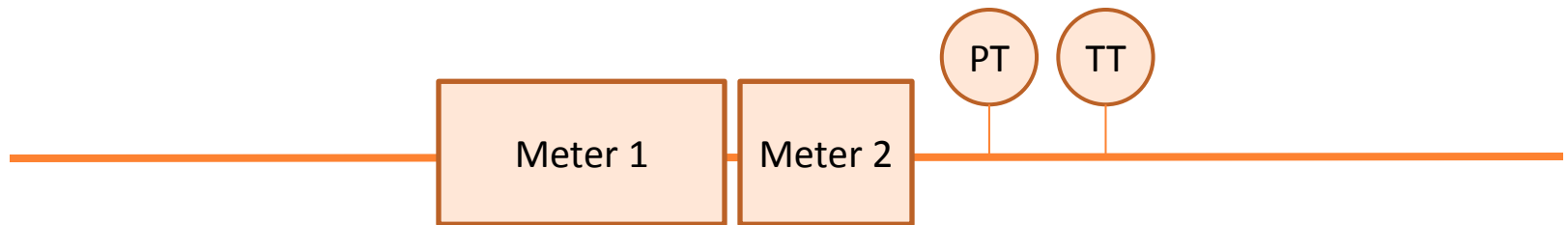
2nd opinion



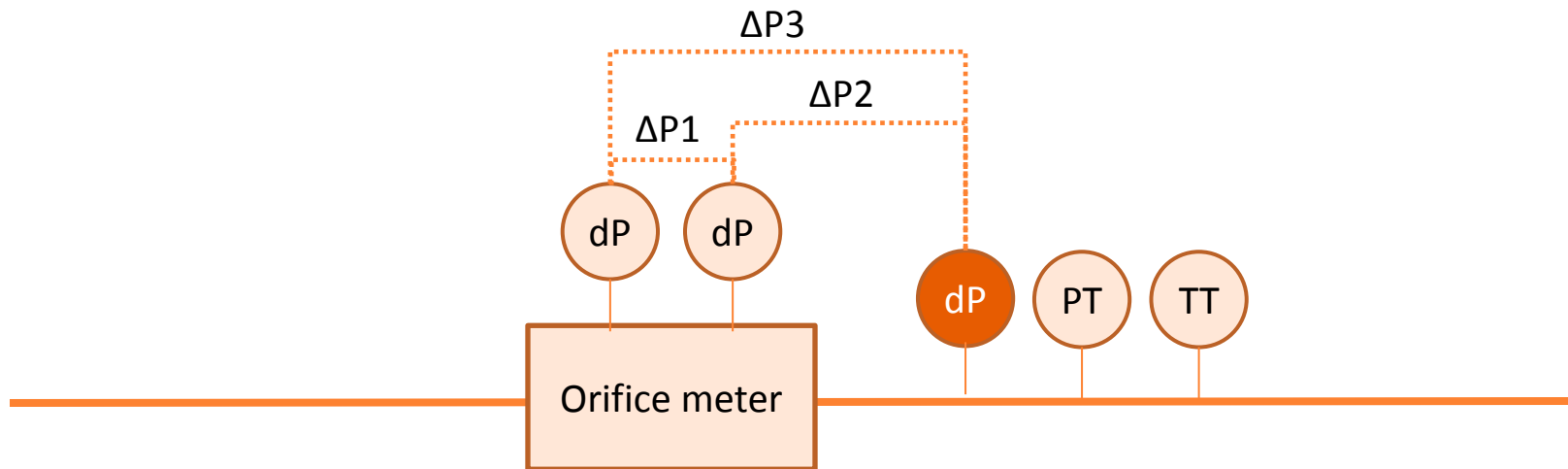
2nd opinion



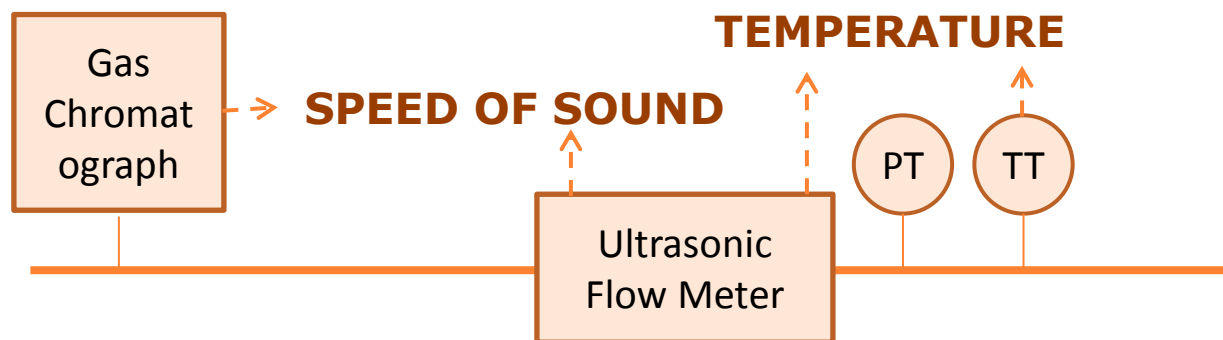
2nd opinion



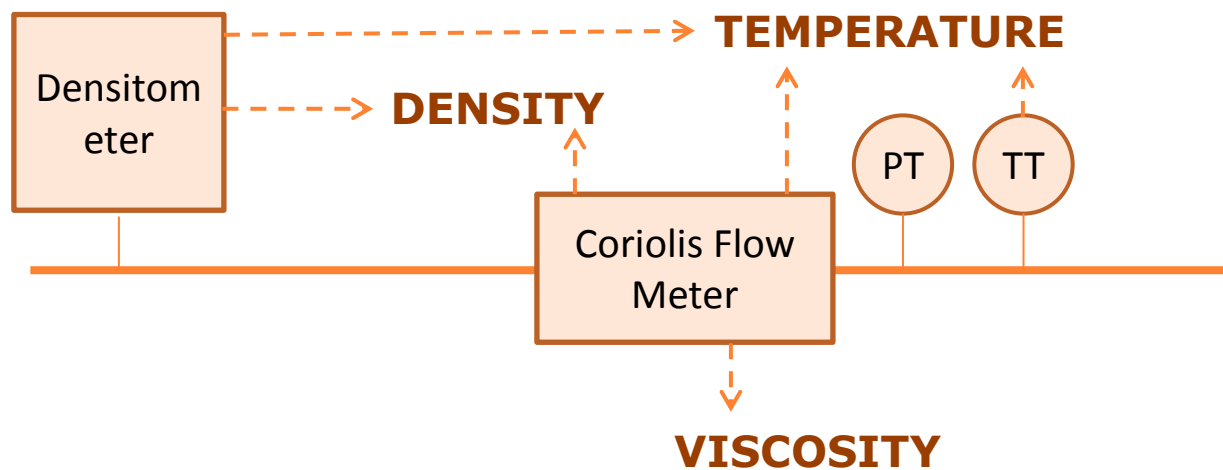
2nd opinion



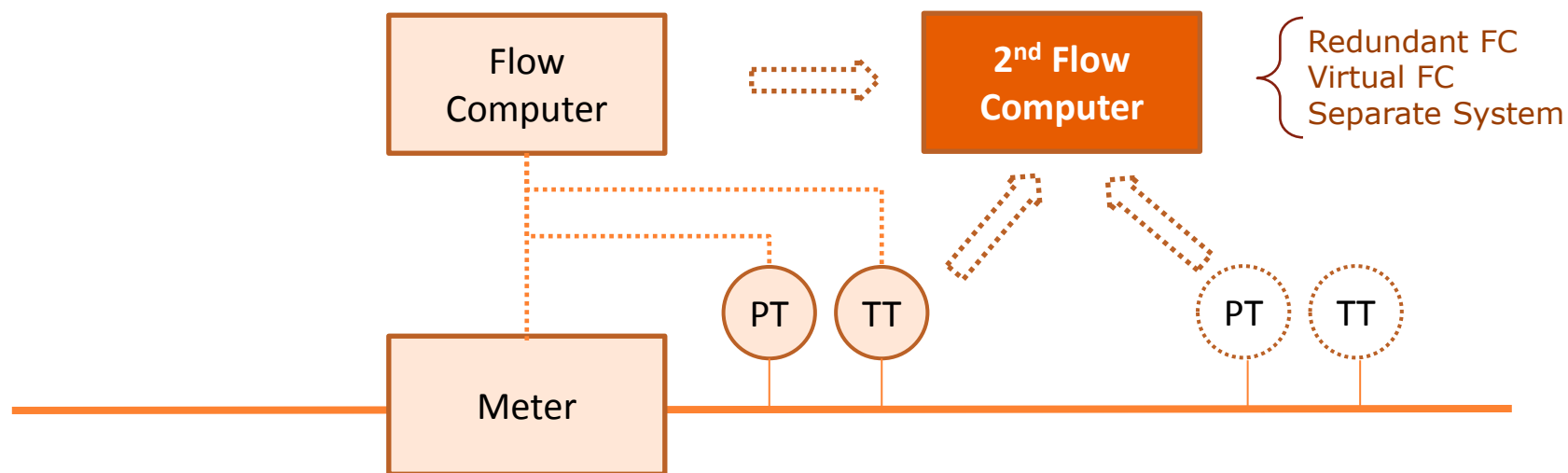
2nd opinion



2nd opinion



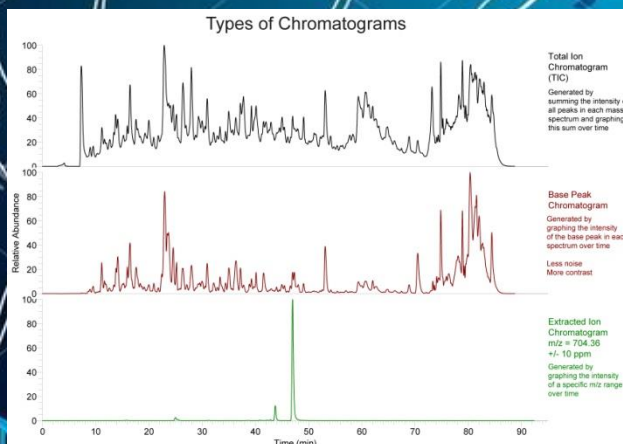
2nd opinion



Diagnostics – Device level

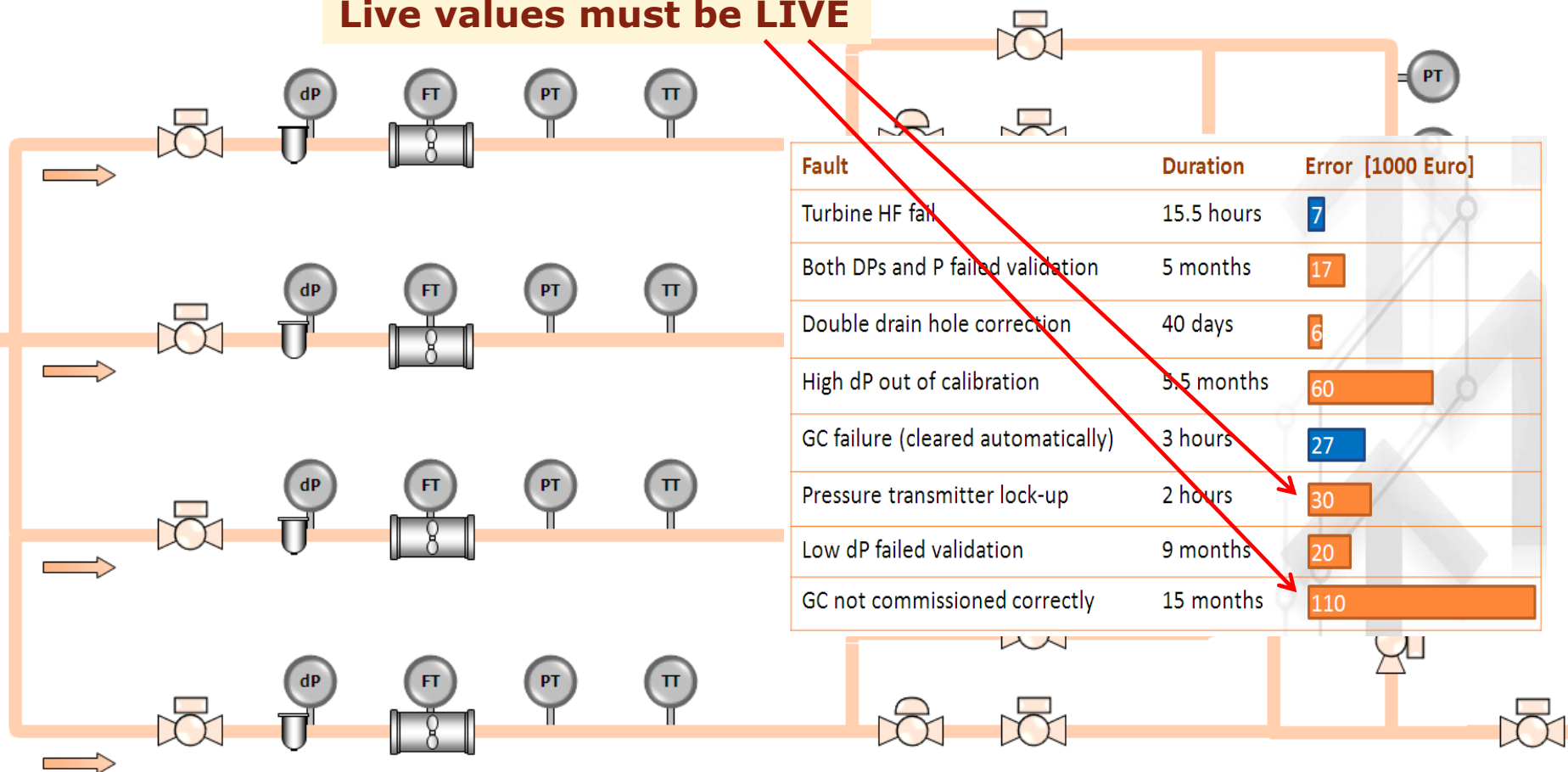
Meter status

Bit	System state register	P1	P2	P3	P4	Path state register	System control register
0	Measure mode					Warning SNR	Configuration mode
1	Measurement valid					Warning AGC deviation	Path 1 inactive
2	Check request					Warning AGC limit	Path 2 inactive
3	Limit warning					Warning SOS deviation	Path 3 inactive
4	Hardware write lock					Read signal from DSP	Path 4 inactive
5	Path error 1					Divide by Zero	Path 1 checkcycle
6	Path error 2					MAX too big	Path 2 checkcycle
7	Path error 3					MAX too small	Path 3 checkcycle
8	Path error 4					MAXPOS too early	Path 4 checkcycle
9	CRC error					MAXPOS too late	Reset error volume counters
10	Parameter invalid					Path error	Imperial unit system
11	Adjust range					SNR exceeds limit	Filter mode
12	I/O range error					Maximum iterations	Testing watchdog
13	DSP error					Time plausibility	Reset path conditions
14	Path compensation valid					Check cycle	Continuous measure mode
15	DSP parameter error					Limit MSE	Air test



Diagnostics – System level : Basic checks

Live values must be LIVE



MMM Detection - Current status

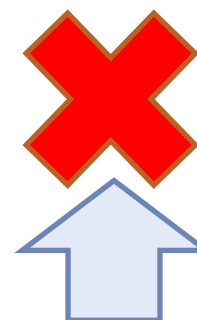
~~2nd opinion~~

~~Diagnostics~~

Proving / Calibration

Audits

Accounting Systems



MMM Detection - Way forward?

2nd opinion

Diagnostics

Proving / Calibration

Audits

Accounting Systems



MMM Detection - Information overload



MMM Detection - The smart way



MMM Correction

Alarm log

...

01/31/12 12:00:56 **Pressure failure** changed from normal to alarm

...

01/31/12 17:34:20 Pressure failure changed from alarm to normal

...

What is the **error** in the daily net volume?

10, 100, 1000 MSCF ?

MMM Correction

Substitute value

DAILY AVERAGES

Orifice Bore	IN	10.9
Temperature	F	70.61
Pressure	PSIG	314.6
Density	LB/ACF	1.11

&

Correction method



Daily Gross Total	MACF	5319
Daily NET Total	MSCF	122022
Daily MOCF Total		122953

Substitute value : Without MMM

Da	Da	Date : 01/01/12	Time : 00:00:00
Da	Da	DAILY VALUES	
Da	Da	Daily Gross Total MSCF	5010
Da	Da	Daily NET Total MSCF	122022
Da	Da	Daily MASS Total Klb	5078
Da	Da	Daily Energy Total MMBTU	131626
Da	Da	Net Delivery Time hh:mm	24: 0
Da	Da	Cum. Net Open MSCF	180774149
Da	Da	Cum. Net Close MSCF	180895372
Da	Da	Cum. Energy Open MMBTU	193260465
Da	Da	Cum. Energy Close MMBTU	193382092
Da	Da	DAILY AVERAGES	
Da	Da	Orifice Bore IN	10.5
Da	Da	Temperature F	70.51
Da	Da	Pressure PSIG	314.6
Da	Da	Density Lb/SCF	1.13
Da	Da	Expansion Factor Y	1.00
Da	Da	Combined Flow Factor	27405.14
Da	Da	Average Composition	
Da	Da	Heating Value BTU/SCF	1071.6
Da	Da	Specific Gravity	1.257
Da	Da	Reference Density Lb/FT3	1.05
Da	Da	N2 %	2.79
Da	Da	C3 %	2.25
Da	Da	C4 %	68.10
Da	Da	C5 %	5.28
Da	Da	ICS %	1.53
Da	Da	CS+ %	4.2
Da	Da	ICS %	.24
Da	Da	ICS %	.09
Da	Da	ICS %	.11
Da	Da	ICS %	.10

Meter Tickets



Substitute value : With MMM

Rectification Method

X

Static Pressure [kPa]

☐ 1st order - Redundant Measurement

☒ 2nd order - Virtual Flow Computer

☐ 3rd order - Electronic Flow Meter

☐ 4th order - Nearest Measurement

☐ 5th order - Linear Interpolation 60.42

☐ 5th order - Last Good Value 60.42

☐ 5th order - 1 Hour Moving Average 60.42

☐ 5th order - Average 2days Before & After 60.02

☐ 5th order - Average 1week Before 60.41

☐ Manual Value

☐ Show meta data

OK

Exit

MMM Correction method

Manual of Petroleum Measurement Standards Chapter 21.1

Flow Measurement Using Electronic Metering Systems—Electronic Gas Measurement

ANSI/API MPMS CHAPTER 21.1
SECOND EDITION, FEBRUARY 2013

AGA REPORT NO. 13



AMERICAN PETROLEUM INSTITUTE



American Gas Association



MMM Correction method

5.7.1 Recalculation of Data

Off-site final calculations and on-going revision to metering standards can be addressed by measurement systems using a recalculation and edit process of the QTR. The volume calculation can be corrected in the measurement system using the correction methodology.

$$\text{Corrected Volume} = \frac{\text{Recalculate Volume}_{\text{Corrected Values}}}{\text{Recalculate Volume}_{\text{Original Reported Values}}} \times \text{Reported Volume} \quad (23)$$

“Recalculate Volume_{Corrected Values}” would recalculate the volume using the new equations or changed variable(s) and “Recalculate Volume_{Original Reported Values}” would recalculate the volume using the equation or variable(s) used by the EGM. Multiplying this ratio times the EGM reported volume would correct the volume for these changes. (See Annex C.2.)

MMM Correction method

Annex B (normative)

Averaging Techniques

B.1 Averaging Method

The averaging technique required by this standard is **flow time linear averaging**. Flow time refers to the requirement that when there are periods of partial flow, these values shall only be calculated during the periods of flow as shown in Annex B.2. When there is no flow for the entire period, these values shall be calculated as shown in Annex B.3. These averages are indicated by the subscript “Linear” throughout this standard, for example DP_{Linear} .

MMM Correction method : Case study

Recalculation Gas - Pressure 3 Hour Failure - Ideal Correction Value.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Developer Add-Ins

Normal Page Layout Page Break Preview Custom Views Full Screen

Workbook Views

Gridlines Headings

Zoom 100% Zoom to Selection

New Window Arrange All Freeze Panes

Split View Side by Side Synchronous Scrolling Reset Window Position

Save Workspace Switch Windows

Macros

INDIRECT $\text{=fxISO5167_Orifice(,C86406,F86406,E86406,AE86406,0.00012,1.3,500,0.00001,20,300,0.00001,20,1,1,1,0,1,0,1,3,0)}$

	A	B	C	D	E	F	AC	AD	AE	AI	AJ	AK	AL	AM	AN
1	Period	Time	dP	√QRT(dP*P	T	P			Rho	Rho 15C	tatu	MFR	Mass	GVOL increment	SVOL increment
86386	86380	23:59:40	160.00	123.94	46.91	96.00	0	0.903316208	66.46011501	0.74413841	0	66.8496	66.85	1.005860957	89.83494733
86387	86381	23:59:41	160.00	124.17	46.91	96.37	0	0.903066696	66.73410679	0.74413841	0	66.9872	66.99	1.00379226	90.01978522
86388	86382	23:59:42	161.60	125.98	47.23	98.22	0	0.902299636	68.00334692	0.74413841	0	67.9575	67.96	0.999325729	91.32372862
86389	86383	23:59:43	163.22	125.89	47.55	97.10	0	0.903491308	67.076217	0.74413841	0	67.8292	67.83	1.011235704	91.15121516
86390	86384	23:59:44	164.85	126.76	47.23	97.47	0	0.902788059	67.4518792	0.74413841	0	68.3565			
86391	86385	23:59:45	164.85	127.48	47.23	98.59	0	0.902059142	68.27642249	0.74413841	0	68.7727			
86392	86386	23:59:46	166.50	128.12	47.23	98.59	0	0.902059142	68.27642249	0.74413841	0	69.1148			
86393	86387	23:59:47	166.50	126.90	47.55	96.73	0	0.903740075	66.7977795	0.74413841	0	68.3634			
86394	86388	23:59:48	166.50	126.42	47.55	95.99	0	0.904233363	66.2507573	0.74413841	0	68.0831			
86395	86389	23:59:49	168.16	126.07	47.55	94.51	0	0.90523246	65.15964028	0.74413841	0	67.8563			
86396	86390	23:59:50	169.84	125.71	47.23	93.04	0	0.905804072	64.16940565	0.74413841	0	67.6735			
86397	86391	23:59:51	168.14	124.58	47.55	92.31	0	0.906758246	63.53375753	0.74413841	0	67.0017			
86398	86392	23:59:52	168.14	124.58	47.23	92.31	0	0.906318569	63.62820752	0.74413841	0	67.0509			
86399	86393	23:59:53	168.14	124.09	47.23	91.58	0	0.906837129	63.0882858	0.74413841	0	66.7660			
86400	86394	23:59:54	166.46	124.20	47.55	92.67	0	0.906503229	63.80179432	0.74413841	0	66.8072			
86401	86395	23:59:55	168.13	124.58	47.23	92.30	0	0.906319934	63.62641344	0.74413841	0	67.0466			
86402	86396	23:59:56	166.45	123.21	46.91	91.21	0	0.906662675	62.90982468	0.74413841	0	66.3346			
86403	86397	23:59:57	166.45	123.95	46.91	92.30	0	0.905881081	63.71868758	0.74413841	0	66.7594			
86404	86398	23:59:58	166.45	124.68	47.23	93.40	0	0.905552641	64.43448608	0.74413841	0	67.1335			
86405	86399	23:59:59	166.45	124.44	46.91	93.03	0	0.905364596	64.25919741	0.74413841	0	67.0417	67.04	1.043301542	90.09307792
86406	86400	00:00:00	166.45	123.95	47.23	$\text{=fxISO5167_Orifice(,C86406,F86406,E86406,AE86406,0.00012,1.3,500,0.00001,20,300,0.00001,20,1,1,1,0,1,0,1,3,0)}$									i247
86407															
86408															

1sec 5min hour day overview

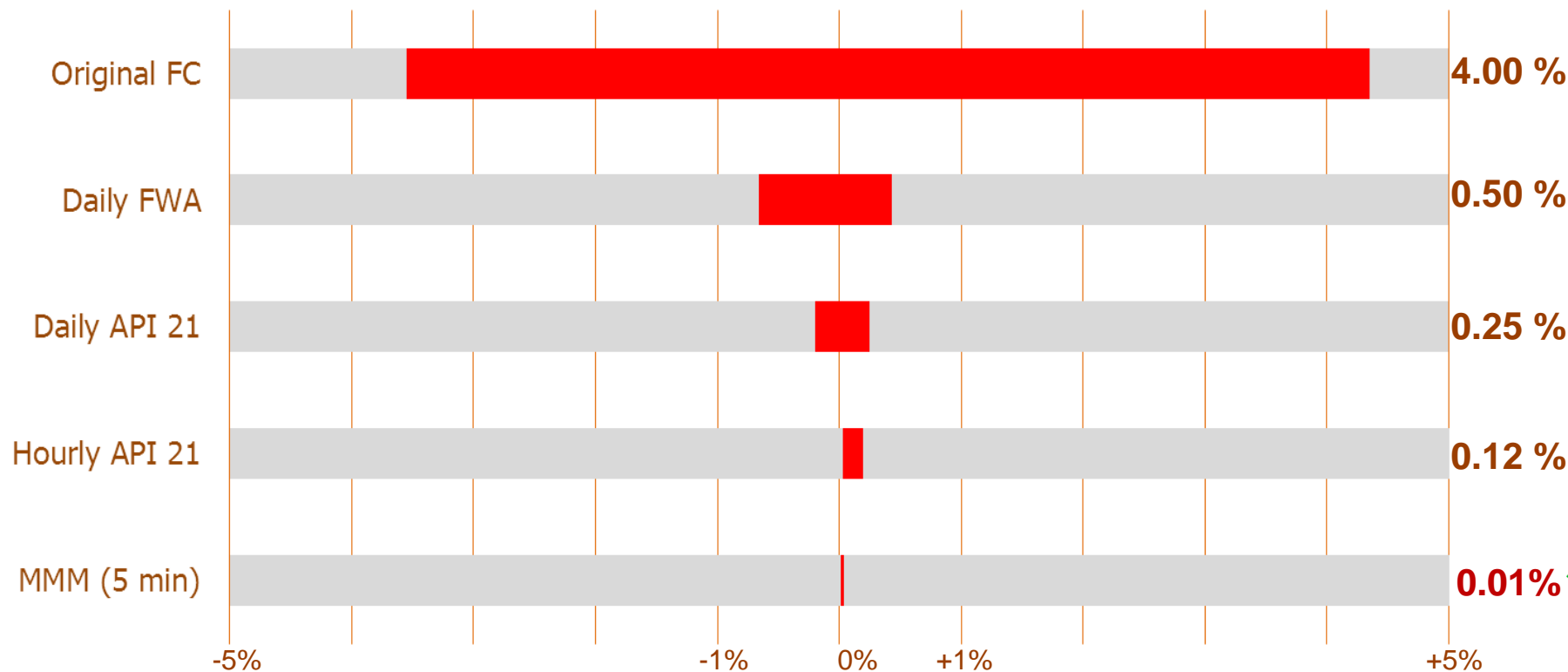
Edit Calculate

100%



MMM Correction method : Case study

Error because of **correction method** in daily standard volume



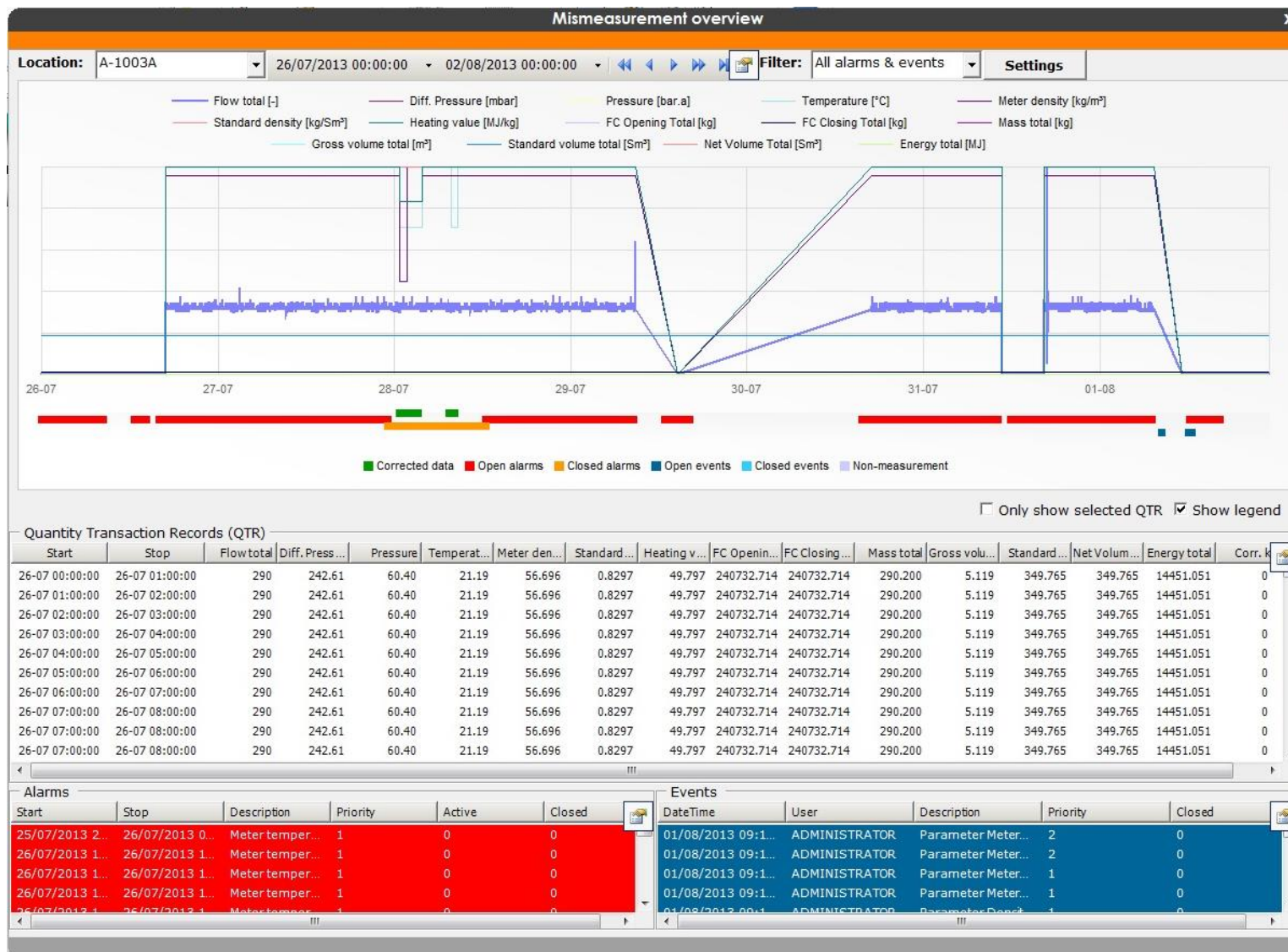
*Orifice gas
5 hour failure of pressure
Last good value
40 test cases
Ideal substitute value*

Design goals of the MMM software

1. To **detect** errors as quickly as possible and whenever possible
2. To draw the user's attention to significant issues only
3. To allow the user to efficiently analyze the issue
4. To suggest accurate substitute values
5. To **correct** errors as accurately as possible
6. To facilitate **automatic billing** corrections
7. To ensure full compliance with API MPMS Chapters 21.1 and 21.2

CONTROL YOUR MEASUREMENT DATA

MisMeasurement Management Software



Questions?

Please feel free to ask!

Thank you!



Find us online