Combined Accuracy

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Introduction

We use the term Combined Accuracy to define the error in both the meter and the instrument in a single figure. This figure also helps us stay within rules/policies requiring us to measure within a preset tolerance. I believe we all want to provide our customers with the most accurate bill, according to their usage, as we can possibly obtain. Using Combined Accuracy allows us to get there by accounting for error in both pieces of our measurement equipment.

The typical gas meter setup found in residential or low volume commercial customers consists of a meter by itself. Since there is only one measuring device, there is no combined accuracy calculation. The meter accuracy, by itself, dictates its measurement accuracy through its meter check proof.

Combined Accuracy comes into play usually with your larger, high demand commercial applications where an Electronic Volume Corrector is employed with the gas meter. We now have two measurement devices working in tandem. With two measurement devices, we have two accuracy points to contend with.

There are a plethora of different meter setups coupled with Electronic Volume Correctors. For this paper, we will address the most common, how to obtain a Combined Accuracy figure for a positive displacement Rotary Meter with Electronic Volume Corrector. We will also use a 1.0% tolerance for a Fast Meter, as well as a Slow Meter. After all, I don't think we want to give away gas on the Slow-side! For the EC, we will figure a tolerance on +/-0.5%

Where Do We Obtain Our figures?

There are two different ways of calculating your Combined Accuracy. There are advantages and disadvantages to both. The first requires less programming in the field, but limits your meter usage as your Combined Accuracy is calculated solely by the meter and Electronic Corrector, or "EC" characteristics.

The second approach is where the technician programs a Factor to offset for the meter error into the EC. This Factor is typically called a Meter Factor or Auxiliary Factor. By programming this Factor into the EC, you are biasing the EC to take the meter error into account. The meter error would be corrected at the Instrument level, and included in your Corrected Read.

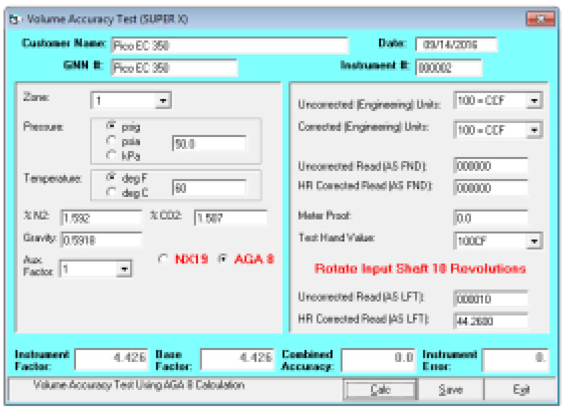
All of the figures used for the Combined Accuracy calculation come from Meter and the EC characteristics.

EC Accuracy

In either approach, you must first obtain the Electronic Corrector's accuracy result. At my place of employment, we may obtain Electronic Corrector accuracy using one of two approaches:

<u>VAT</u>

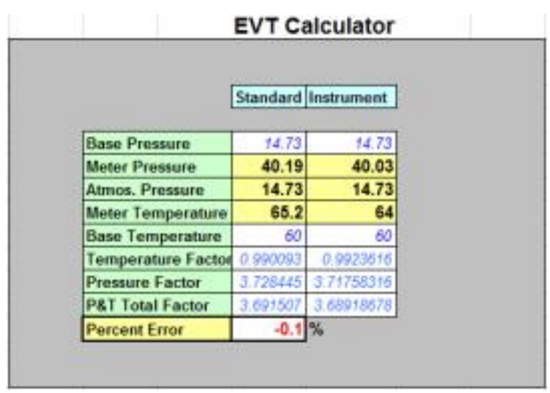
Our Instrument Shop will always perform a VAT (Volume Accuracy Test) after programming an EC for any site.



The Volume Accuracy Test has a definite advantage over our second approach. The VAT will physically check the switches in the EC during the test, check for measurement configuration error (Super Compressibility, PSIA, Units of Measure, Test Hand Value), and also measure Pressure Transducer and RTD (Temperature) error. Our field personnel will utilize the VAT method whenever measurement is questionable in the slightest degree, or during any meter change or field proving function. (Our VAT will also detect an incorrect Meter/Auxiliary Factor when it is set up properly). The test simply takes the variables programmed into it and performs a calculation on these preset parameters, delivering a "perfect" calculation. The EC is tested by spinning the input drive (simulating gas usage) and delivers its calculation dependant on its programming and live measurement input. The two calculations are compared and the Instrument Error is the difference between the two calculations. If the programming in the EC was correct, matching the variables input into the VAT Program, and the hardware was functioning correctly, the error would be entirely reflective of transducer and/or RTD error, if so equipped.

<u>EVT</u>

Our field technicians will use a simplified method of obtaining and recording the EC's accuracy immediately after receiving an instrument from our Instrument Shop. It is called an EVT. (Electronic Verification Test)



This test will measure <u>ONLY</u> the pressure transducer and, if equipped, RTD (Temperature) accuracy. Pressure Factors and Temperature Factors are calculated for both the Standard and EC. The associated Factors are combined and the figures then compared giving us a Percentage of Error result. This test is more forgiving in the field environment than the VAT; however, it will only measure Pressure Transducer and RTD error. When a new EC is set, redundancy testing is eliminated as the EC has had the VAT performed prior to installation by the Instrument Shop. This approach also saves time by simplifying the procedure. Planned EC Inspections are also tested using this simplified method, as long as all appears well with the EC and it proves to be in-tolerance during the test.

Meter Accuracy

Meter accuracy can be obtained by the Manufacturer's Meter Check Proof. We will use the Manufacturer's Check Proof at 25% Flow Rate. The figure may also be obtained during a Meter Proving operation (FMT, or Field Meter Test). Meters rebuilt at our facility will come with a new Check Proof provided by using a properly certified Meter Prover. Meters proved in the field by field personnel may also deliver a new Check Proof using properly certified equipment.

Putting Combined Accuracy Together

Now we have obtained our 2 figures; our EC Accuracy, either by VAT or EVT, and our Meter Check Proof. The first method we will discuss would simply entail adding the Meter Check Proof and EC Accuracy figures together. If the Meter Check Proof is -0.2% and the EC Accuracy was -0.4%, then your Combined Accuracy would be -0.6%. Simple enough. To provide your customer with the most accurate measurement, the Combined Accuracy may be factored into the bill by the Billing Department. The disadvantage to this method is in dealing with your Combined Accuracy tolerance. If your goal is to measure within a 1% tolerance window, you may be limited in the specific meter you can place into service. Let's say your EC accuracy comes in at -0.4%, and the meter your technician plans on installing has a Check Proof of -0.7%.

-0.4% plus -0.7% = -1.1%; outside of your 1.0% tolerance. You would be limited in placing a meter with no more than -0.6% Check Proof. At -0.6, you would be measuring right at the -1.0% tolerance window, with no wiggle room.

As Found:
Current (FMT or Historical) Meter Check Proof + EC Accuracy Test Result = Combined Accuracy

As Left:
Meter Check Proof + EC Accuracy Test Result = Combined Accuracy

As you can see with this plan, as the meter error changes, you may find a need to change out, or clean the meter to bring your Meter Set Assembly back into your measurement window, or calibrate an "in tolerance" EC. I don’t believe calibrating an in-tolerance EC is ever a viable answer.

Another way of figuring your Combined Accuracy, method 2, is to effectively offset the meter error by biasing your EC. This is done through programming the EC to calculate the meter error out of the Uncorrected Volume value. To accomplish this, we will need to convert the Check Proof into a number the EC can use in a calculation. (See Table 1) After all, a Check Proof figure of +0.2% is not usable in a calculation in this form. +0.2% Check Proof means that there is an additional 2/10ths of 1% additional gas measured than was actually passed. (Fast Meter) To deduct this additional erroneously measured gas, we need to convert the +0.2% into a number usable by the EC to apply to the Uncorrected Volume. We would take the "extra" 0.2%, or .0020 from 1.0 (1.0 - .0020 = 0.9980) Uncorrected Volume times 0.9980 will deduct the +0.2% erroneous measurement. This is commonly known as the EC Bias Effect. The EC Bias Effect in this example is -0.2%. By factoring out your meter error at the Instrument level, you can now install any meter, up to your tolerance window, irrespective of your EC Accuracy error. This method avoids attempting to calibrate your EC when it is measuring within tolerance, in an attempt to accommodate a specific meter. It also allows the continued use of a meter which is in tolerance and allows for the error to be electronically adjusted out within the EC. Here is the formula for calculating Combined Accuracy using method 2.

As Found: EC Bias Effect + Current (FMT or Historical) Meter Check Proof + EC Accuracy Test = Combined Accuracy.

As Left: EC Bias Effect + Meter Check Proof + EC Accuracy Test = Combined Accuracy.

One drawback in this method is if a technician forgets to set the Meter/Auxiliary Factor in the EC. The formula remains the same, but our measurement has suffered as a result of technician error. Let's say the Meter Check Proof was +0.3, the technician left an old Meter/Auxiliary Factor of 0.9940 programmed into the EC and our EC Accuracy was -0.5. We would calculate the Combined Accuracy we have been measuring at using the same formula.

EC Bias Effect -0.6 Meter Check Proof +0.3 EC Accuracy -0.5
-0.6 plus +0.3 plus -0.5 equals -0.8 Combined Accuracy.

Examples of Combined Accuracy

Example 1:

In this example, we will demonstrate an order which a Field Meter Test is performed to check meter accuracy and obtained a new Check Proof to use.

FMT w/EC Inspection (Method 1)

As Found
FMT -0.7%
EC Accuracy Test -0.4%
-0.7 plus -0.4 equals -1.1% Combined Accuracy.
Measurement is Out of Tolerance.

Field Work:
Change meter/Clean meter. Your As Left meter will need to be at no more than -0.6% to measure at the edge of the 1.0% tolerance window.

FMT w/EC Inspection (Method 2)

As Found
FMT -0.7%
EC Bias Effect +0.4%
EC Accuracy Test -0.4%

It appears our meter has slowed-down by 0.3% since it was last set, as demonstrated by our As Found EC Bias Effect.
-0.7 plus +0.4 plus -0.4 equals -0.7% Combined Accuracy.

Field Work:

Change the Meter/Auxiliary Factor to 1.0070 to Bias the EC by +0.7%

As Left Combined Accuracy is

-0.7 plus +0.7 plus -0.4 equals -0.4% Combined Accuracy.

No meter work/replacement needed to be done to stay within the +/- 1.0% measurement tolerance window in method 2. A simple electronic adjustment was used to factor out the meter error. We are 0.6% away from the edge of the 1.0% tolerance window, using the same meter with no physical intervention!

Example 2:

In this example we will use a Planned/Routine Meter Change (PMC) w/EC Inspection, using our Historical Meter Check Proof.

PMC w/EC Inspection (Method 1)

As Found

Historical Meter Check Proof -0.2%

EC Accuracy Test +0.3%

-0.2 plus +0.3 equals +0.1% Combined Accuracy.

Your As Left meter will need to be at no more than +0.9% to measure at the edge of the +1.0% tolerance window or can be up to -1.0%. This method, with the meter Check Proof being opposite of the EC Accuracy, helped the overall Combined Accuracy.

PMC w/EC Inspection (Method 2)

As Found

EC Bias Effect +0.2

Historical Meter Check Proof -0.2%

EC Accuracy Test +0.3%

+0.2 plus -0.2 plus +0.3 equals +0.3% Combined Accuracy.

Your As Left meter can be up to either +/- 1.0% and you will still be at least 0.7% away from the +1.0% tolerance window.

Example 3:

In this example we will use a Planned EC Inspection order. We will utilize our Historical Meter Check Proof.

EC Inspection (Method 1)

As Found

Historical Meter Check Proof -0.5%

EC Accuracy Test -0.1%

-0.5 plus -0.1 equals -0.6% Combined Accuracy.

Your As Left meter is within tolerance as well as your EC accuracy. With the equipment left as is, you will be 0.4% away from the edge of the -1.0% tolerance window.

EC Inspection (Method 2)

As Found

EC Bias Effect +0.5

Historical Meter Check Proof -0.5%

EC Accuracy Test -0.1%

+0.5 plus -0.5 plus -0.1 equals -0.1% Combined Accuracy.

Your As Left meter is within tolerance as well as your EC accuracy. With the equipment left as is, you will be 0.9% away from the edge of the -1.0% tolerance window.

Example 4:

In this example we will use a Planned EC Inspection order. We will utilize our Historical Meter Check Proof.

EC Inspection (Method 1)

As Found
Historical Meter Check Proof -0.5%
EC Accuracy Test -0.7%
-0.5 plus -0.7 equals -1.2% Combined Accuracy.

Your As Left meter is within tolerance. The EC Accuracy is Out of Tolerance. Combined Accuracy is at -1.2%

Field Work:
Calibrate the EC back into tolerance; at a minimum of +/-0.5%. Lets say the EC has been calibrated and is now at +0.1% Accuracy. Our As Left Combined Accuracy will now be -0.5 plus +0.1 equals -0.4%. We will be 0.6% away from the edge of our -1.0% tolerance window.

EC Inspection (Method 2)

As Found
EC Bias Effect +0.5
Historical Meter Check Proof -0.5%
EC Accuracy Test -0.7%
+0.5 plus -0.5 plus -0.7 equals -0.7% Combined Accuracy.

Your As Left meter is within tolerance. The EC Accuracy is Out of Tolerance. Combined Accuracy is at -0.7%. We were still measuring within our +/- 1.0% overall tolerance window.

Field Work:
Calibrate the EC back into tolerance; at a minimum of +/-0.5%. Lets say the EC has been calibrated and is now at +0.1% Accuracy. Our As Left Combined Accuracy will now be +0.5 plus -0.5 plus +0.1 equals +0.1%. We will be 0.9% away from the edge of our +1.0% tolerance window.

The Benefits of Combined Accuracy

The use of Combined Accuracy has its place in our field, not just in Policies and Regulations, but in providing the most accurately calculated measurement with which to bill our customers.

Implementing any new method into any department will have its costs. Field training, billing department training, new policies, and record keeping, to name a few. These startup costs may be recoverable through the savings of a well designed program.

Combined Accuracy calculations may be of use to offset for lost gas (LUAF, or Lost and UnAccounted For). In the scheme of Rules and Regulations, every little bit of lost gas we can explain is no longer lost gas!

Use of a Meter/Auxiliary Factor scheme may allow for a "tighter" As Left accuracy tolerance, thus giving more wiggle room within the tolerance window. Less maintenance and material expenses may be realized. Your overall measurement tolerance window may be preserved, even when one of your measurement devices becomes out of tolerance.

References:

WinMup – Measurement Utilities Program for Windows, Copyright Steve Albano Southern California Gas Co. 1999, 2004, 2006.
This program is used to calculate EC accuracy during a Volume Accuracy Test (VAT) on an EC.

Table 1

Meter Check Proof	Meter/Aux Factor	EC Bias Effect
+1.0	0.990	-1.0
+0.9	0.991	-0.9
+0.8	0.992	-0.8
+0.7	0.993	-0.7
+0.6	0.994	-0.6
+0.5	0.995	-0.5
+0.4	0.996	-0.4
+0.3	0.997	-0.3
+0.2	0.998	-0.2
+0.1	0.999	-0.1
0.0	1.000	0.0
-0.1	1.001	+0.1
-0.2	1.002	+0.2
-0.3	1.003	+0.3
-0.4	1.004	+0.4
-0.5	1.005	+0.5
-0.6	1.006	+0.6
-0.7	1.007	+0.7
-0.8	1.008	+0.8
-0.9	1.009	+0.9
-1.0	1.010	+1.0