A Guide to Understanding Flow Calibration Certificates

Brad Sims

CEESI

Flow calibration certificates provide valuable and detailed information, but this information is sometimes misunderstood or misapplied. This paper outlines important terminology, reviews the various sections of certificates, discusses commonly misunderstood information, and then steps through an example certificate.

Terminology (when applied to Flow Calibration Certificates):

Traceable to the SI: A measurement that can be linked to the International System of Units (SI) through an unbroken chain of measurements.

NIST: The Nation Institute of Standards and Technology (NIST) is a federal agency of the United States that supports measurements and is often used as the source for SI Traceability.

Uncertainty: A parameter, associated with the result of a measurement, which characterizes the dispersion of the values that could reasonably be attributed to the measurand. The uncertainty statistically estimates the "doubt" in the absolute correctness of a measurement.

Confidence Level: The probability that the value of a parameter falls within a specified range. Typical presented as a 95% confidence level in measurement.

Error: The difference between a reference valve and an indicated value. Error is typically provided as a percentage but can also be provided as an absolute value.

Primary Calibrations: Calibrations that rely on the measurement of fundamental units such as mass, length, or time to determine the flow rate measurement.

Secondary Calibrations: Calibrations that rely on conditional measures and equations to infer flow rates from flow meters that have traceability back through a primary calibration.

As Found: Refers to the calibration or testing of a meter being performed in the exact state that it was received.

As Left: Refers to the calibration or testing of a meter state after any required changes such as cleaning, updating calibration coefficients, repair, etc.

Meter Reading: The value being outputted by the meter under test. This could be an analogue signal such as a milliamp value, a digital panel reading, or some other recordable quantity.

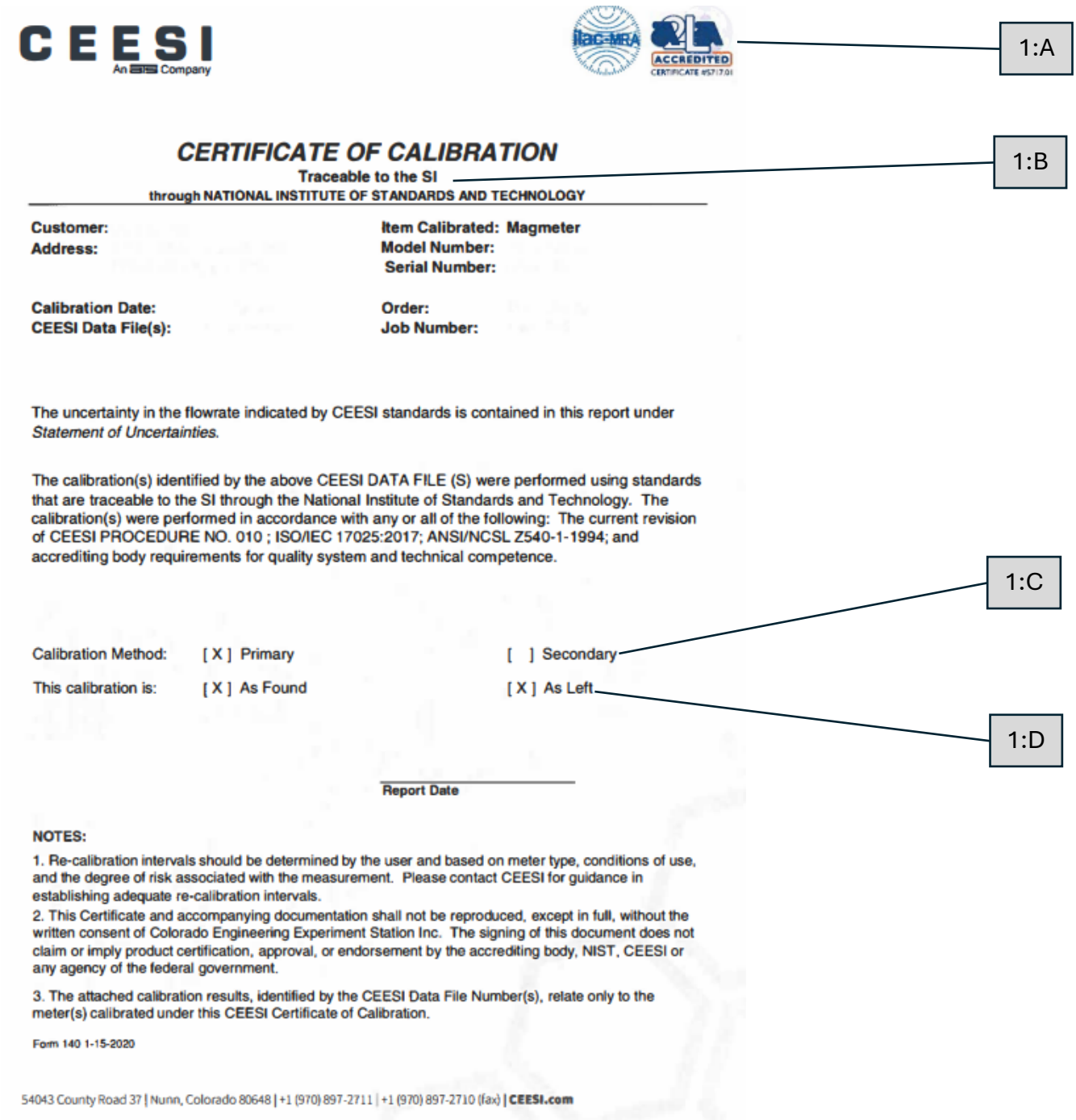
Indicated: This is the meter reading scaled correctly to provide a flow rate with the applicable units so it can be compared to a reference flow rate.

Standard (Density, Pressure, or Temperature): Refers to a predefined set of conditions that are not necessarily the same as the actual conditions during a calibration. Typically specified as a Standard Pressure and a Standard Temperature which is used to define the Standard density.

Calibration Certificate Review:

The calibration certificate examples are from CEESI but all accredited certificates from other laboratories should contain similar information.

Figure 1, Title Page: The title page identifies the meter being calibrated, provides information on the calibrating laboratory, and on the type of calibration being performed.



CEESI
An Company

ilac-MRA ACCREDITED CERTIFICATE #5717.01

1:A

CERTIFICATE OF CALIBRATION

Traceable to the SI

through NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

1:B

Customer:
Address:

Item Calibrated: Magmeter
Model Number:
Serial Number:

Calibration Date:
CEESI Data File(s):

Order:
Job Number:

The uncertainty in the flowrate indicated by CEESI standards is contained in this report under *Statement of Uncertainties.*

The calibration(s) identified by the above CEESI DATA FILE (S) were performed using standards that are traceable to the SI through the National Institute of Standards and Technology. The calibration(s) were performed in accordance with any or all of the following: The current revision of CEESI PROCEDURE NO. 010 ; ISO/IEC 17025:2017; ANSI/NCSL Z540-1-1994; and accrediting body requirements for quality system and technical competence.

1:C

Calibration Method: [X] Primary [ ] Secondary

This calibration is: [X] As Found [X] As Left

1:D

Report Date

NOTES:

1. Re-calibration intervals should be determined by the user and based on meter type, conditions of use, and the degree of risk associated with the measurement. Please contact CEESI for guidance in establishing adequate re-calibration intervals.
2. This Certificate and accompanying documentation shall not be reproduced, except in full, without the written consent of Colorado Engineering Experiment Station Inc. The signing of this document does not claim or imply product certification, approval, or endorsement by the accrediting body, NIST, CEESI or any agency of the federal government.
3. The attached calibration results, identified by the CEESI Data File Number(s), relate only to the meter(s) calibrated under this CEESI Certificate of Calibration.

Form 140 1-15-2020

54043 County Road 37 | Nunn, Colorado 80648 | +1 (970) 897-2711 | +1 (970) 897-2710 (fax) | **CEESI.com**

Figure 1

1:A Identifies the accreditation organization and the certification number. This number can be used to look up the full accreditation and scope information for a calibration laboratory.

1:B States the traceability chain for the calibration. In this example the calibration is Traceable to the SI through NIST.

1:C This states the calibration was performed using a primary or a secondary flow reference.

1:D This states if the calibration was performed on the "As Found" or "As Left" flow meter conditions. If both are selected, then the meter was tested in the same condition as it arrived, and no changes were made so the as-found and as-left conditions are the same.

Figure 1 and Figure 2, Calibration Overview: The calibration overview pages provide information on the meter being calibrated, details on the setup, environmental conditions, and test media specifications.

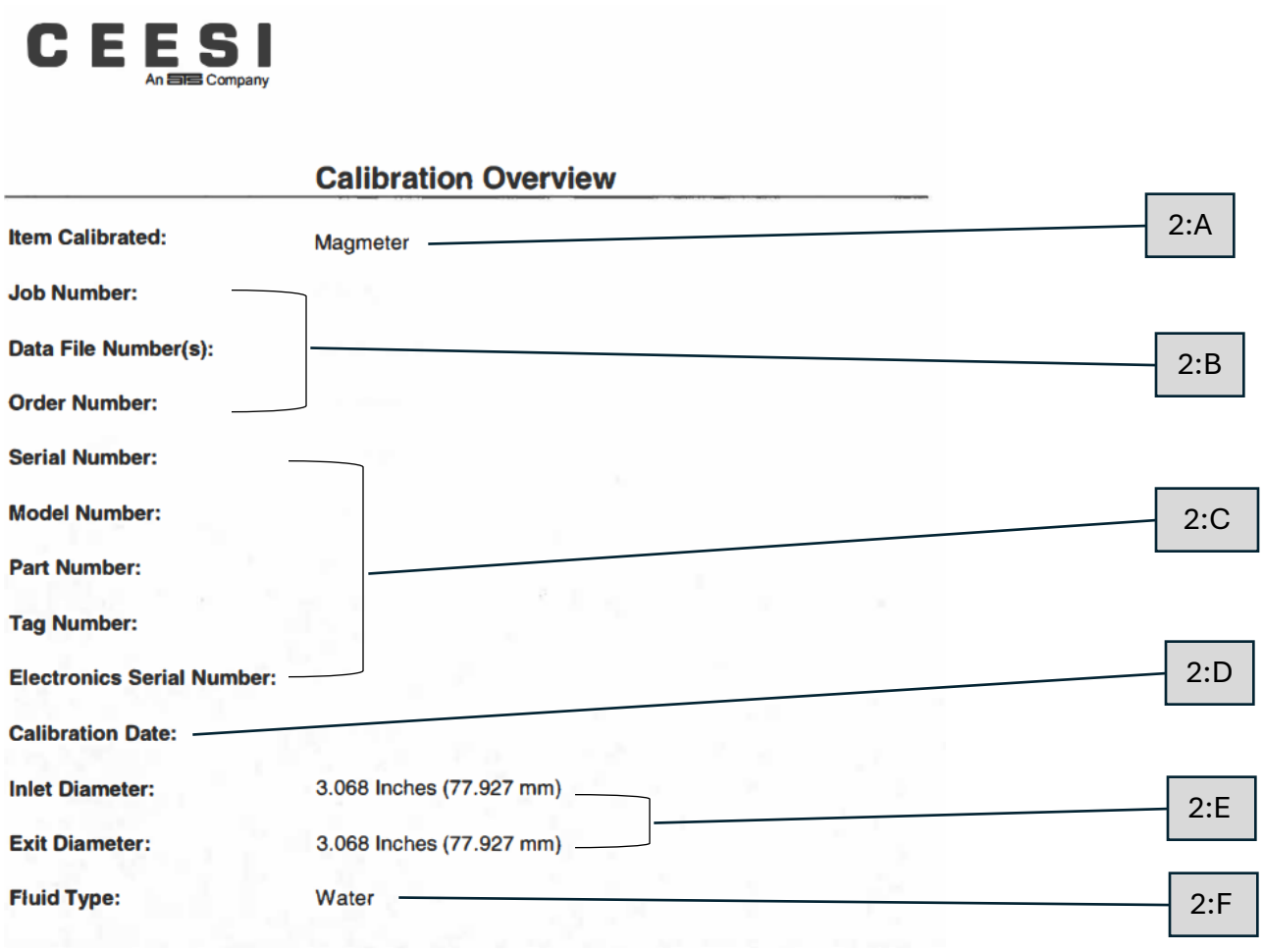


Figure 2

2:A Identifies the general meter type being calibrated.

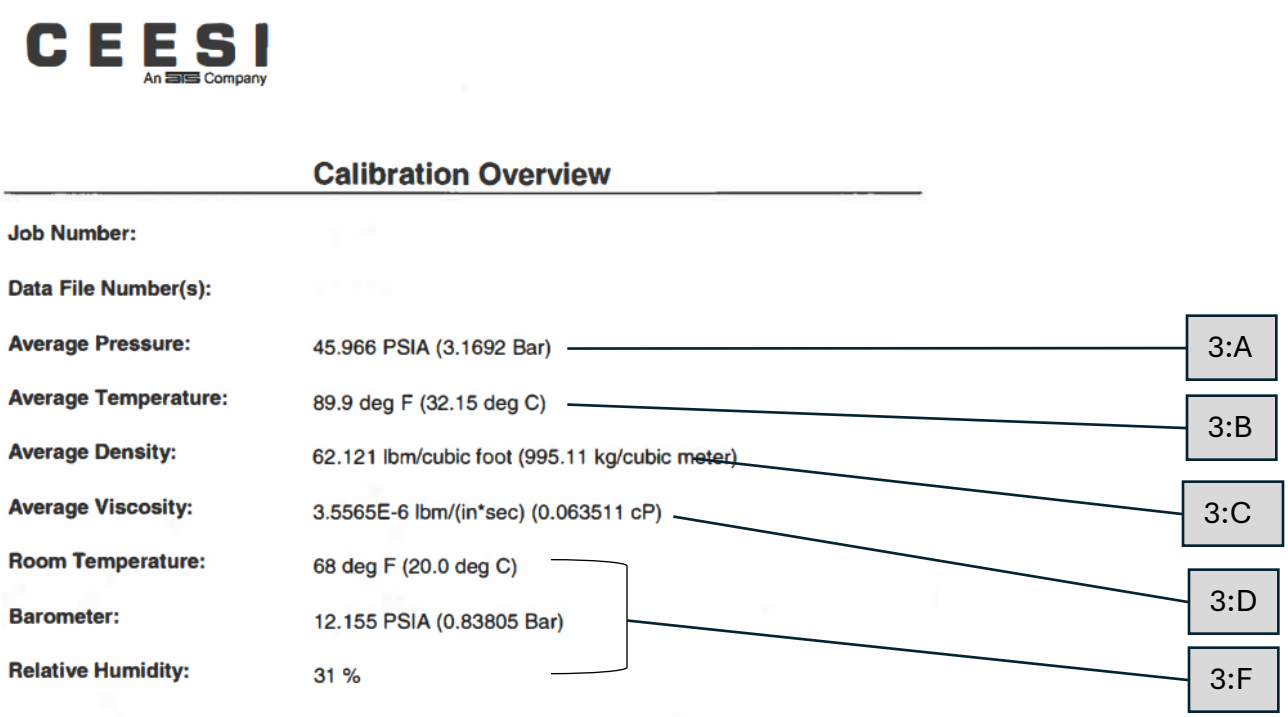
2:B Numbers being used by the calibration laboratory to identify the job and the calibration data.

2:C Numbers that specifically identify the meter and/or hardware included with the meter.

2:D The date that the calibration was performed.

2:E The size of the conduits used to attach to the meter.

2:F The flowing media used to perform the calibrations.



CEESI
An AIS Company

Calibration Overview

Job Number:	
Data File Number(s):	
Average Pressure:	45.966 PSIA (3.1692 Bar)
Average Temperature:	89.9 deg F (32.15 deg C)
Average Density:	62.121 lbm/cubic foot (995.11 kg/cubic meter)
Average Viscosity:	3.5565E-6 lbm/(in*sec) (0.063511 cP)
Room Temperature:	68 deg F (20.0 deg C)
Barometer:	12.155 PSIA (0.83805 Bar)
Relative Humidity:	31 %

Figure 3

3:A The average absolute pressure of the flowing media used to calibrate the meter.

3:B The average temperature of the flowing media used to calibrate the meter.

3:C The average density of the flowing media used to calibrate the meter.

3:D The average viscosity of the flowing media used to calibrate the meter.

3:F The ambient conditions; temperature, pressure, and humidity when the calibration was performed.

Figure 4, Calibration Data: The data pages provide the calibration data in tabulated form. The column entries can either be directly measured value, like pressure, or calculated values, like meter factor.

CEESI
An SIS Company

Calibration of Magmeter

Serial Number:
Job Number: **Data File Number:**

Pt.	Data point number
MtrRead	Meter Reading, in milliAmps
IndVDot	Indicated volumetric flowrate, gallons per minute
VDot	Volumetric flowrate, gallons per minute
Error	Percent error of indicated to actual flowrate
Density	Flowing density, pounds mass per cubic foot
Press	Fluid static pressure, pounds per square inch absolute
Temp	Fluid temperature, degrees Fahrenheit
Visc	Viscosity of fluid, pounds mass per inch seconds

Pt.	MtrRead [mA]	indVDot [GPM]	VDot [GPM]	Error [%]	Density [lbm/ft^3]	Press [psia]	Temp [°F]	Visc [lbm/(in*sec)]
1	20.064	910.96	910.6	0.04	62.12	31.419	89.74	4.2746E-05
2	18.182	804.26	803.29	0.12	62.121	36.569	89.75	4.2739E-05
3	16.565	712.63	712.19	0.06	62.121	40.561	89.77	4.2727E-05
4	14.787	611.79	611.17	0.1	62.121	44.134	89.85	4.2691E-05
5	13.139	518.35	518.23	0.02	62.122	46.962	89.83	4.2697E-05
6	11.436	421.81	421.83	-0.01	62.122	49.266	89.87	4.2682E-05
7	9.7176	324.37	324.26	0.03	62.122	51.02	89.92	4.2656E-05
8	8.0644	230.64	230.45	0.08	62.122	51.792	89.93	4.2649E-05
9	6.3513	133.51	133.14	0.28	62.121	52.997	89.99	0.00004262
10	4.695	39.602	39.298	0.77	62.121	54.939	90.1	4.2567E-05

4:A
4:B
4:C
4:D
4:E

Figure 4

4:A The title block lists what each column provides and the units.

4:B The meter reading, or meter output. For this meter the output is in milliamps.

4:C: This is the indicated flow rate from the meter. This is the meter reading converted to a flow rate using the provided scaling.

4:D: This is the reference flow rate from the calibration laboratory flow standard.

4:E This is the percentage difference (assumed to be error) between the indicated flow rate and the reference flow rate.

Figure 5, Calibration Uncertainty: The uncertainty pages provide the uncertainty in each of the measured or calculated values from the calibration data.

CEESI
An SS Company

Statement of Uncertainties

Serial Number:
Job Number: **Data File Number:**

Pt.	Data point number
MtrRead	Uncertainty in amperage
IndVDot	-
VDot	Uncertainty in volumetric flowrate
Error	-
Density	Uncertainty in density
Press	Uncertainty in pressure
Temp	Uncertainty in temperature
Visc	Uncertainty in viscosity

All uncertainties are listed as a % of read at a 95% confidence level (k=2)

Pt.	MtrRead [%]	IndVDot [-]	VDot [%]	Error [-]	Density [%]	Press [%]	Temp [%]	Visc [%]
1	0.017	-	0.12	-	0.06	0.25	0.1	0.25
2	0.017	-	0.12	-	0.06	0.25	0.1	0.25
3	0.017	-	0.12	-	0.06	0.25	0.1	0.25
4	0.017	-	0.12	-	0.06	0.25	0.1	0.25
5	0.017	-	0.12	-	0.06	0.25	0.1	0.25
6	0.017	-	0.12	-	0.06	0.25	0.1	0.25
7	0.017	-	0.12	-	0.06	0.25	0.1	0.25
8	0.017	-	0.12	-	0.06	0.25	0.1	0.25
9	0.017	-	0.12	-	0.06	0.25	0.1	0.25
10	0.017	-	0.12	-	0.06	0.25	0.1	0.25

5:A
5:B
5:C
5:D
5:E
5:F
5:G
5:H

Figure 5

5:A The title block lists what each column provides.

5:B This defines if the uncertainties are a % or reading or an absolute value and what the confidence limit is. Typically, the confidence limit is 95% (k=2) but it could also be 68% (k=1) or 99% (k=3).

5:C This is the uncertainty in the measured output from the meter. For this example, this uncertainty is from the instrument and method used to measure the milliamp signal from the meter.

5:D This is the uncertainty in the laboratory reference flow rate.

5:E This is the uncertainty in the reported viscosity which comes from the measured pressure and temperature condition of the media as well as the thermodynamic calculation method.

5:F This is the uncertainty in the media temperature measurement.

5:G This is the uncertainty in the media pressure measurement.

5:H This is the uncertainty in the reported density which comes from the measured pressure and temperature condition of the media as well as the thermodynamic calculation method.

Figure 6, Calibration Checklist: This page list all the instrumentation and references used to perform the calibration

CEESI
An Company

Calibration Checklist

Serial Number:

Job Number: **Data File Number:**

Data Acquisition: CEESI172 **Company:**

QC Supervisor: **Order:**

Setup Conditions: Inlet Pressure, Exit Temperature

6:A

List of Instruments Used:

QC Number	Description	Due Date
1000	Primary Time Signal	12/06/2024
1131	Rosemount 2088	08/30/2024
1525	20k lbm scale (QCs 1516-1519)	02/06/2025
1564	HP-DC172 WL	07/15/2025
1783	Minebea Intec 1500lb scale	02/05/2025

List of Standards Used:

Standard QC Number
PRIWL1
PRIWL4

6:B

Figure 6

6:A This block lists all the instrumentation used and their quality control numbers.

6:B This block lists all the flow references used and their quality control numbers.

Commonly misunderstood concepts and sections of flow calibration certificates.

Recalibration Intervals: One of the most common questions regarding flow calibration certificates is what is the required re-calibration time interval and why is that not included on the certificate? CEESI does not provide this on calibration certificates as the frequency of recalibration will be dependent on the conditions of use, meter type, uncertainty requirement, risk sensitivity, etc. and must be defined by the end user. For example, a meter used with abrasive or corrosive fluid may be eroded or contaminated during operation and require recalibration more often than that same meter type being used with a clean noncorrosive fluid.

Pass/Fail Statements: CEEIS is often asked to Provide Pass or Fail statements on our calibration certificates. While some laboratories will do that based on a provide or manufacturer specification CEESI just presents the as-found data and then as-left data if an adjustment is made. This allows the user to determine what quantifies a pass or failure depending on their specific application.

Volumetric Flow: Volumetric flow rate is typically presented as “actual” or “standard” with each being distinctly different. Actual volumetric flow rate, ex. ACFH, is the volumetric flow rate at the actual flowing media density during the calibration. This actual volumetric flow rate is the measured mass flow rate divided by the density of the fluid at the meter. This typically requires the flow rate to be measured as well as the temperature and pressure at the meter in order to calculate the media density. Standard volumetric flow rate, ex. SCFM, is a volumetric flow rate at a defined density. Since standard volumetric flow rate is a volume per time at a defined density it is functionally a mass flow rate. This standard volumetric flow rate is the measured mass flow rate divided by the density of the fluid at the defined standard temperature and pressure conditions.

Meter Outputs: Often flow meters output some reading which is noted as the "meter reading" in CEESI certificates. This output can be a milliamp value, a voltage value, a frequency, or something else. This output then needs to be converted to a flow rate so that the rate can be compared to the reference meter rate. Often that output is linear with flow rate and gets scaled to the correct value. Example 1 shows this calculation.

Example 1:

$$Meter\ Output\ Range = 4\ to\ 20\ mA$$

$$Meter\ Max\ Flow = 100\ SCFM$$

$$Meter\ Min\ Flow = 0\ SCFM$$

$$M \times mA + b = SCFM$$

$$M = 6.25$$

$$b = -25$$

$$Meter\ Output = 10\ mA$$

$$6.25 \times 10 - 25 = 37.5\ SCFM$$

For some meters, like turbines, the "Meter reading" is frequence shown in Example 2.

Example 2:

$$Turbine\ meter\ defined\ Kfactor = 20 \text{ pulses/ft^3}$$

$$measure\ frequncey = 1000$$

$$ft^3/\sec = freq/K$$

$$\frac{1000}{20} = 50\ ft^3/sec$$

$$50\ ft^3/sec \times 60\ sec/min = 3000\ ACFM$$

Scaling Meter Outputs: The scaled "meter reading" is shown in the data tables on the certificate as the "indicated flow" which is the flow rate that the meter is outputting. This "indicated flow" is then compared to the reference flow rate to provide the % error.

Calibration Range: A calibration is only valid over the range that it was performed. For example, an orifice plate calibration provides an equation that relates pipe Reynolds number to Discharge coefficient. This equation is only valid between the minimum and maximum Reynolds number that the calibrating was performed. That equation is not applicable outside of the calibration Reynolds number range and can provide incorrect results if extrapolated.

Meter Factor: For some meter types a "Meter Factor" is the main result of a calibration and is the reference flow rate divided by the indicated flow rate. The indicated reading can then be multiplied by the Meter factor to correct it to the indicated flow rate. For example, if a USM reads 95 ACFM and the reference reads 100 ACFM then the meter factor is 1.0526.

Uncertainty: The uncertainty of the main result of the calibration, such as discharge coefficient or meter factor, represents the uncertainty in the calibration but it does not provide the complete uncertainty in the measurement provided by the meter under test when it is used in a final application. The calibration uncertainty contributes to the application uncertainty, but other factors such as application instruments, installation effects, and random effects also need to be included. This results in the application uncertainty being significantly greater than the calibration uncertainty. Often, we see users claim the calibration uncertainty as the application measurement uncertainty which is not correct.

Example: Critical Flow Venturi Calibration Certificate

CEESI
An SIG Company

ilac-MRA ACCREDITED CERTIFICATE #5717.01

CERTIFICATE OF CALIBRATION

Traceable to the SI
through NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

Customer:
Address:

Item Calibrated: Critical Flow Venturi
Model Number:
Serial Number:

Calibration Date:
CEESI Data File(s):

Order:
Job Number:

7:A

The uncertainty in the flowrate indicated by CEESI standards is contained in this report under *Statement of Uncertainties.*

The calibration(s) identified by the above CEESI DATA FILE (S) were performed using standards that are traceable to the SI through the National Institute of Standards and Technology. The calibration(s) were performed in accordance with any or all of the following: The current revision of CEESI PROCEDURE NO. 010 ; ISO/IEC 17025:2017; ANSI/NCSL Z540-1-1994; and accrediting body requirements for quality system and technical competence.

7:B

Calibration Method: [ ] Primary [X] Secondary

7:C

This calibration is: [X] As Found [X] As Left

Report Date

NOTES:

1. Re-calibration intervals should be determined by the user and based on meter type, conditions of use, and the degree of risk associated with the measurement. Please contact CEESI for guidance in establishing adequate re-calibration intervals.
2. This Certificate and accompanying documentation shall not be reproduced, except in full, without the written consent of Colorado Engineering Experiment Station Inc. The signing of this document does not claim or imply product certification, approval, or endorsement by the accrediting body, NIST, CEESI or any agency of the federal government.
3. The attached calibration results, identified by the CEESI Data File Number(s), relate only to the meter(s) calibrated under this CEESI Certificate of Calibration.

Form 140 1-15-2020

Figure 7

7:A The calibration was performed on a Critical Flow Venturi

7:B The calibration was performed using a Secondary flow reference.

7:C The calibration was As Found and As Left indicating nothing was changed on the meter under test.

CEESI
An Company

Calibration Overview

Item Calibrated:	Critical Flow Venturi
Job Number:	
Data File Number(s):	
Order Number:	
Serial Number:	
Model Number:	
Part Number:	
Tag Number:	
Electronics Serial Number:	
Calibration Date:	
Inlet Diameter:	0.870 Inches (22.098 mm)
Throat Diameter:	0.088 Inches (2.235 mm)
Fluid Type:	Air
Standard Density:	0.074913 lbm/cubic foot (1.2000 kg/cubic meter)
Standard Pressure:	14.696 PSIA (101.324 KPa)
Standard Temperature:	70 deg F (21.1 deg C)

8:A

8:B

8:C

8:D

Figure 8

8:A The inner diameter of the conduit upstream of the critical flow venturi is 0.87 inches

8:B The throat diameter of the critical flow venturi is 0.088 inches

8:C The flowing media was air.

8:D The standard (defined) conditions were 14.696 psia and 70 deg F and therefore the standard air density was 0.0749 lbm/ft^3

CEESI
An ETG Company

Calibration Overview

Job Number:	
Data File Number(s):	
Average Pressure:	72.872 PSIA (5.0243 Bar)
Average Temperature:	74.3 deg F (23.52 deg C)
Average Density:	0.36902 lbm/cubic foot (5.9113 kg/cubic meter)
Average Viscosity:	1.0349E-6 lbm/(in*sec) (0.01848 cP)
Room Temperature:	68 deg F (20.0 deg C)
Barometer:	12.187 PSIA (0.84022 Bar)
Relative Humidity:	31 %

9:A

9:B

9:C

9:D

Figure 9

9:A The average pressure, temperature, density, and viscosity of the flowing media during the calibration.

9:B The average room temperature during the calibration.

9:C The barometric pressure during the calibration.

9:D The ambient relative humidity during the calibration (not related to the humidity of the flowing media).

CEESI
An ETS Company

Calibration of Critical Flow Venturi

Serial Number:
Job Number: **Data File Number:**

Pt.	Data point number
Press	Meter static pressure, pounds per square inch absolute
Temp	Fluid temperature, degrees Rankine
MDot	Mass flowrate, pounds mass per second
ReyNo	Throat Reynolds number, dimensionless
Cd	Discharge coefficient, dimensionless
Density	Flowing density, pounds mass per cubic foot
Cstar	Critical flow factor, dimensionless

Pt.	Press (psia)	Temp (°R)	MDot (lbm/sec)	ReyNo [-]	Cd [-]	Density (lbm/ft^3)	Cstar [-]
1	122.68	533.62	0.017098	238490	0.99198	0.6221	0.68715
2	113.37	533.21	0.015792	220520	0.99133	0.57521	0.68698
3	104.09	533.29	0.014485	202360	0.99061	0.52798	0.6868
4	94.766	533.4	0.013172	184100	0.98988	0.48048	0.68663
5	85.41	533.33	0.011864	165920	0.98945	0.43301	0.68645
6	76.019	533.21	0.010554	147710	0.98909	0.38542	0.68627
7	66.631	533.37	0.0092451	129430	0.98886	0.33765	0.68609
8	57.257	533.55	0.0079362	111140	0.98826	0.29	0.68591
9	47.874	533.74	0.0066279	92839	0.98753	0.24234	0.68574
10	38.485	533.94	0.0053181	74512	0.98614	0.1947	0.68556
11	29.087	534.15	0.0040091	56183	0.98403	0.14707	0.68538
12	19.659	534.35	0.0027	37847	0.98097	0.099343	0.6852
13	29.099	534.63	0.0040089	56142	0.98404	0.147	0.68538
14	47.908	534.78	0.0066266	92681	0.98762	0.24203	0.68573
15	66.704	534.84	0.009243	129120	0.98894	0.33708	0.68608
16	85.532	534.88	0.011864	165550	0.98946	0.43236	0.68643
17	104.25	534.91	0.014482	201850	0.99046	0.52715	0.68678
18	122.87	534.95	0.017107	238150	0.99224	0.62146	0.68713

10:A
10:B
10:C
10:D
10:E
10:F
10:G

Figure 10

10:A The inlet pressure to the critical flow venturi in psia.

10:B The inlet temperature to the critical flow venturi in Rankine.

10:C The reference mass flow rate in lbm/sec.

10:D The calculated throat Reynolds number for the critical flow venturi based on the reference mass flow rate.

10:E The calculated Discharge Coefficient for the critical flow venturi based on the reference mass flow rate.

10:F The air density at the inlet of the critical venturi based on the measured pressure and temperature.

10:G The calculated throat Reynolds number for the critical flow venturi based on the measured conditions.

CEESI
An ETS Company

Statement of Uncertainties

Serial Number:
Job Number: **Data File Number:**

Pt.	Data point number
Press	Uncertainty in pressure
Temp	Uncertainty in temperature
MDot	Uncertainty in mass flowrate
ReyNo	Uncertainty in Reynolds Number
Cd	Uncertainty in discharge coefficient
Density	Uncertainty in density
Cstar	Uncertainty in critical flow factor

All uncertainties are listed as a % of read at a 95% confidence level (k=2)

Pt.	Press [%]	Temp [%]	MDot [%]	ReyNo [%]	Cd [%]	Density [%]	Cstar [%]
1	0.027	0.094	0.34	2.0	0.34	0.1	0.05
2	0.029	0.094	0.34	2.0	0.34	0.1	0.05
3	0.032	0.094	0.34	2.0	0.34	0.1	0.05
4	0.035	0.094	0.34	2.0	0.34	0.1	0.05
5	0.039	0.094	0.34	2.0	0.34	0.1	0.05
6	0.043	0.094	0.34	2.0	0.35	0.1	0.05
7	0.05	0.094	0.34	2.0	0.35	0.1	0.05
8	0.023	0.094	0.34	2.0	0.34	0.1	0.05
9	0.027	0.094	0.34	2.0	0.34	0.1	0.05
10	0.034	0.094	0.34	2.0	0.34	0.1	0.05
11	0.045	0.094	0.34	2.0	0.35	0.1	0.05
12	0.031	0.094	0.34	2.0	0.34	0.1	0.05
13	0.045	0.094	0.34	2.0	0.35	0.1	0.05
14	0.027	0.093	0.34	2.0	0.34	0.1	0.05
15	0.049	0.093	0.34	2.0	0.35	0.1	0.05
16	0.039	0.093	0.34	2.0	0.34	0.1	0.05
17	0.032	0.093	0.34	2.0	0.34	0.1	0.05
18	0.027	0.093	0.34	2.0	0.34	0.1	0.05

11:A
11:B
11:C
11:D
11:E
11:F
11:G

Figure 11

11:A The uncertainty in inlet pressure to the critical flow venturi in psia.

11:B The uncertainty in inlet temperature to the critical flow venturi in Rankine.

11:C The uncertainty in the reference mass flow rate in lbm/sec.

11:D The uncertainty in calculated throat Reynolds number for the critical flow venturi based on the reference mass flow rate.

11:E The uncertainty in the calculated Discharge Coefficient for the critical flow venturi based on the reference mass flow.

11:F The uncertainty in air density at the inlet of the critical venturi based on the measured pressure and temperature.

11:G The uncertainty in the calculated throat Reynolds number for the critical flow venturi based on the measured conditions.

CEESI
An [redacted] Company

Calibration Checklist

Serial Number:

Job Number: **Data File Number:**

Data Acquisition: CEESI (Pluto) **Company:**

QC Supervisor: **Order:**

Setup Conditions: Inlet Pressure, Inlet Temperature

12:A

List of Instruments Used:

QC Number	Description	Due Date
2800	PLUTO DAQ-NI9361/NI9207	Apr 4 2025 12:00AM
2810	PLUTO Mensor 15 psia	Apr 4 2025 12:00AM
2811	PLUTO Mensor 200 psig	Apr 4 2025 12:00AM
2813	PLUTO Mensor 15 psig	Apr 4 2025 12:00AM
2814	PLUTO Mensor 50 psig	Apr 4 2025 12:00AM
2815	PLUTO Mensor 150 psig	Apr 4 2025 12:00AM
2840	PLUTO Thermistor	Apr 4 2025 12:00AM
2841	PLUTO Thermistor	Apr 4 2025 12:00AM
2842	PLUTO Thermistor	Apr 4 2025 12:00AM
2843	PLUTO Thermistor	Apr 4 2025 12:00AM
2860	PLUTO Mensor 10 INWC	Apr 4 2025 12:00AM
2861	PLUTO Mensor 2 psid	Apr 4 2025 12:00AM
2862	PLUTO Mensor 15 psid	Apr 4 2025 12:00AM
2863	PLUTO Mensor 75 psid	Apr 4 2025 12:00AM

12:B

List of Standards Used:

Standard QC Number
CFV109623
CFV109624
CFV109625
CFV109626
CFV109627
CFV109628
CFV109629
CFV4-032
CFV5-046
LTB-PLUTO

Page 7 of 7

Figure 12

12:A Pressure and temperature instrumentation used during calibration.

12:B Reference flow meters used during calibration.