

Velocity dependent Correction Factors (VCF)

One of the fundamental installation issues with any insertion flow element or transmitter is the proper setup of the correction factors between point velocity measurements and the process flow (integration of many equal area point velocity measurements). Due to viscous drag, the velocity tends to be highest in the center of the process duct, stack or pipe for long runs. Near corners, valves or line size changes there will be other velocity profile issues that can also be adjusted for using this method if they are repeatable.

There are two common methods used to establish correction factors:

- Theoretical estimate based on the duct size, gas type etc. (with long straight runs can be +/- 5 % accurate)
- Field calibration (traverse, tracer gas etc.), can be +/- 5%, +/- 2.5% respectively even with non-ideal flow profiles.

Once the velocity dependent correction factors have been established, there are up to 8 data sets or points (7 for 155 and MFT) that can be programmed to multiply against the raw velocity average to make the corrected velocity average. The MFT line, MFT B-Series and 155 Flow Computers all share the same algorithm for correction factors. To explain how this algorithm works, we have five cases to look at.

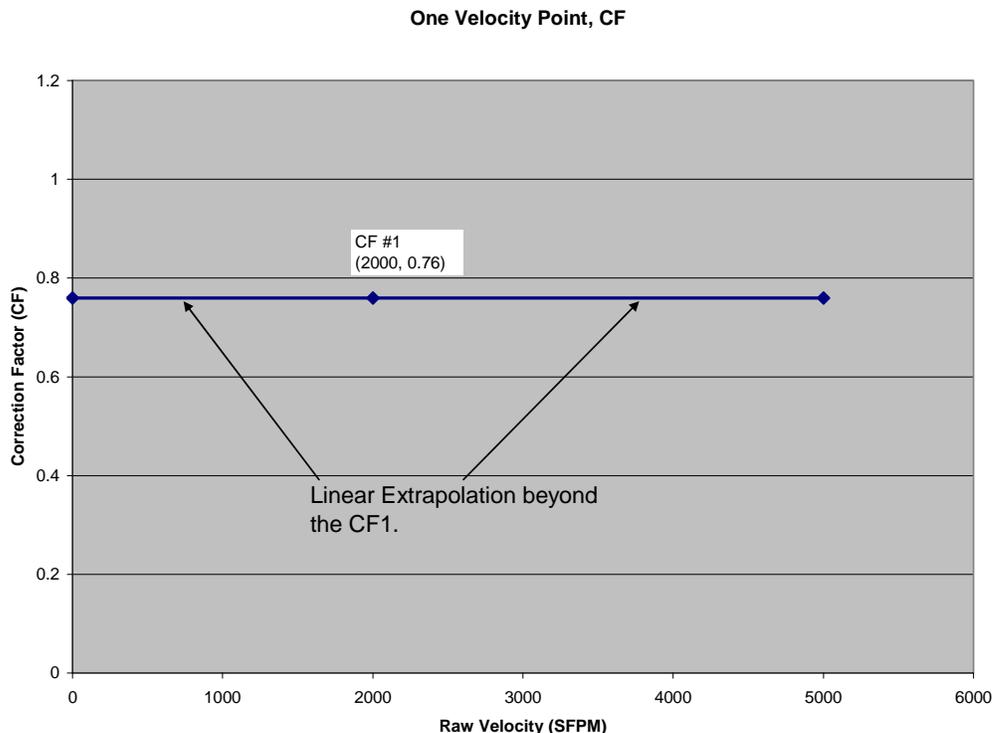


Figure AK-1 Correction factor function with one data point.

In the case of one data point we see this correction factor applies to all velocities above and below the value entered. It therefore does not matter what velocity is used to enter the correction factor.

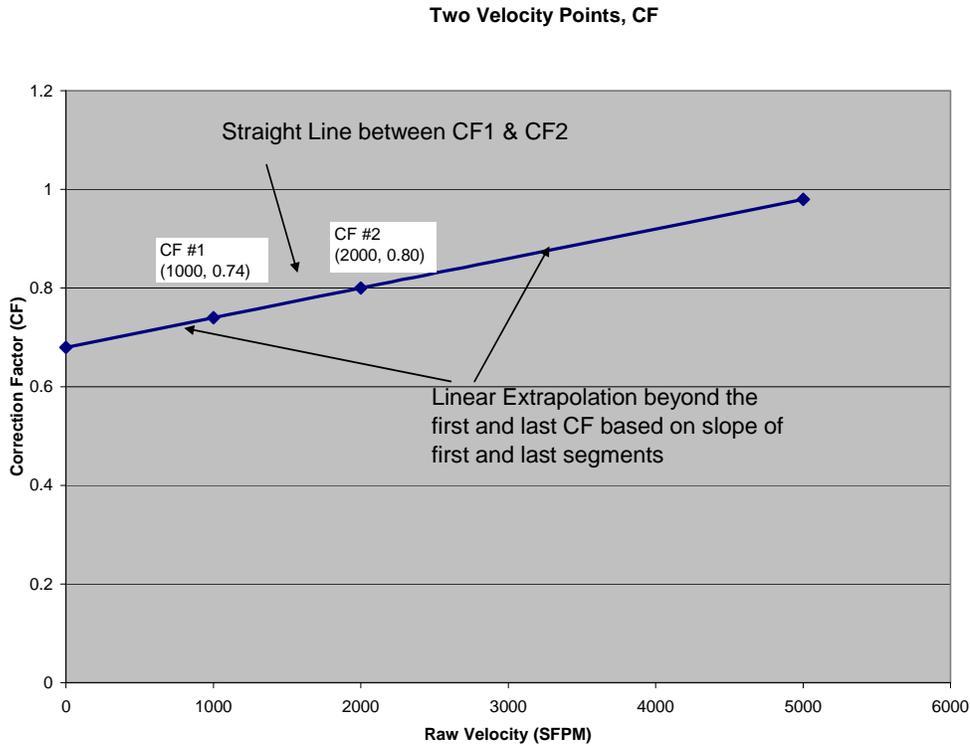


Figure AK-2. Correction Factor function with two data points.

When two correction factors are entered, a simple straight line is used between these points which also applies above and below the values entered as shown in Figure AK-2.

When three correction factors are entered, there are two straight lines used. The first line is based on CF1 and CF2 and applies between these points and at velocities below this. The second line is based on CF2 and CF3 and all points above these velocities as shown in Figure AK-3.

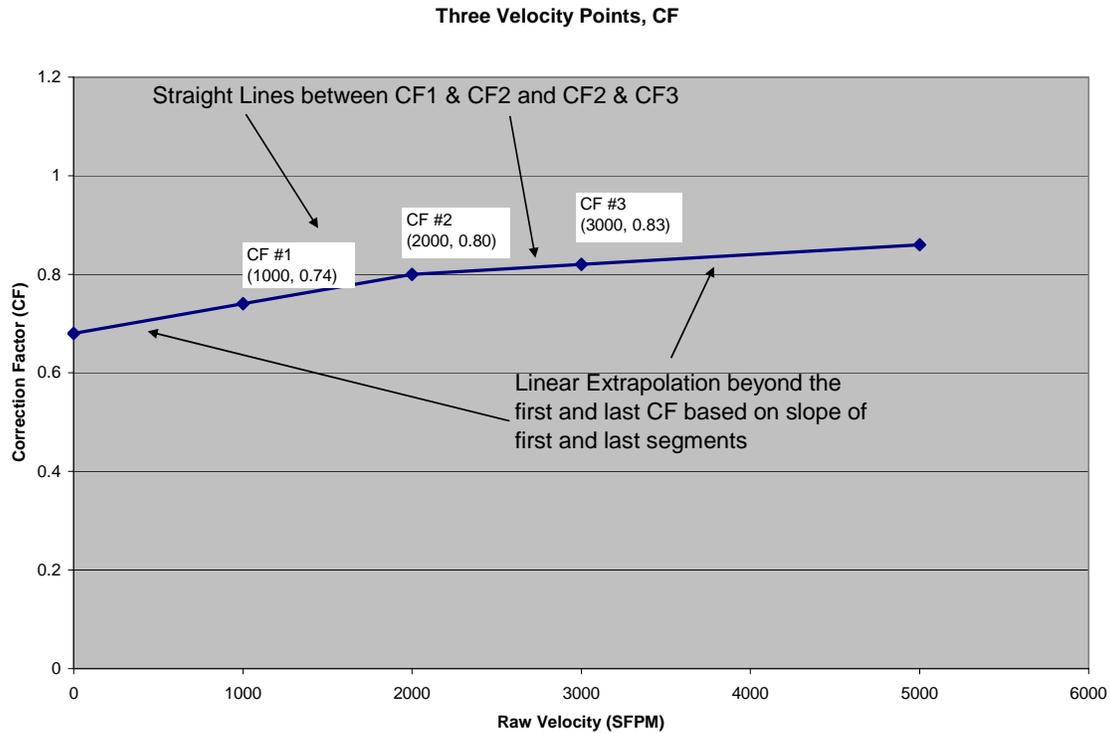


Figure AK-3. Correction Factor function with three data points.

Warning

If points are placed too close in velocity to each other with CF that vary too much, you will get very large swings in the CF, especially with velocities outside or beyond lower and upper end points.

Recommendations

It is recommended that all correction factors be inspected in a spreadsheet for their smoothness before programming into a Kurz flow meter or flow computer.

Alternately, set the first CF at 0 velocity and the last at the Max. velocity so you are never extrapolating from the slope of the first and last segments. This ensures the CF is a reasonable value over the velocity range of interest.

If four points or more are used, the correction factors for the center points are second order smooth curves. The first and last segments are still straight lines as well as velocities above and below the first and last points as shown in Figures AK-4 and AK-5.

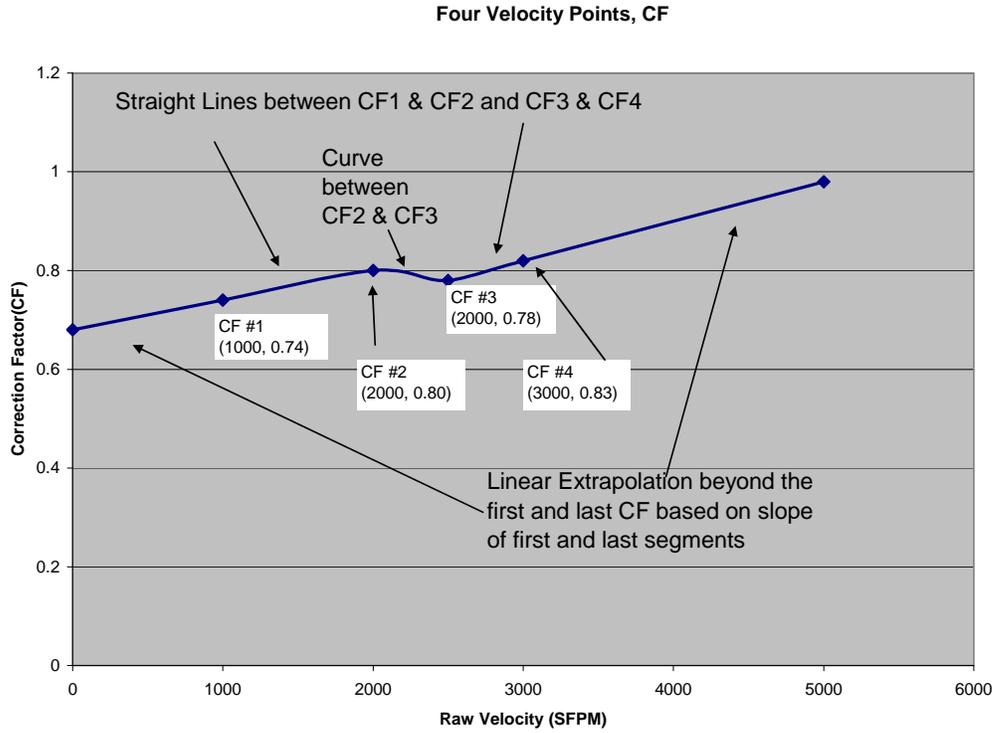


Figure AK-4. Correction Factor function with four data points.

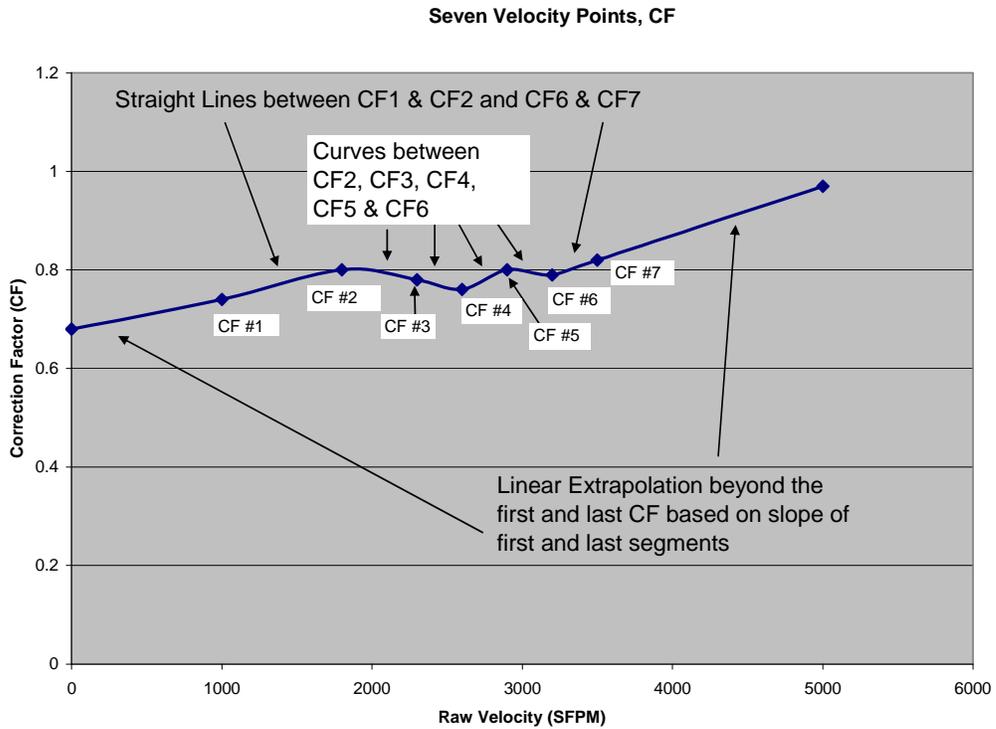


Figure AK-5. Correction Factor function with five data points.

User Menus for Variable CF

Before looking at the user menus used with the 2x16 LCD interface for the correction factor data, we need to understand some nomenclature first.

Nomenclature

The variable correction factor examples shown in Figures AK-1 to AK-5 have a CF at velocity X. However, the actual meter menus for this data are based on two velocity numbers, the reference velocity (R) at the observed velocity data (D) as shown in Table AK-1.

Table AK-1 Comparison of Reference velocity (**R or V_{rm}**), Observed velocity Data (**D or V_{ds}**) and computed **CF**

Data Set #	R (MFT & MFT B) V _{rm} (155)	D (MFT & MFT B) V _{ds} (155)	CF
1	740	1000	0.74
2	1440	1800	0.8
3	1794	2300	0.78
4	1976	2600	0.76
5	2320	2900	0.8
6	2528	3200	0.79
7	2870	3500	0.82

Collecting the data then graphing it in a spreadsheet requires making a new column as shown above, $CF = R/D$. Then the graph of CF vs. D can be made to ensure it is smooth and extrapolates to lower and higher velocities as needed.

The 155 multipoint flow computer uses indicated velocity data for each input channel associated with a meter as well as the process average velocity. The extra data is used to make the best correction factor estimate possible if a sensor is "Kicked out" or removed from the average. Table AK-2 compares this nomenclature between the single point and multipoint meters.

Table AK-2. Three velocity data set comparisons of the data needed for a four sensor 155 multipoint system and a single point MFT or MFT B meter.

	Velocity Data Set #	Reference Velocity Average	Indicated Sensor Velocity Data
155 * CF type =CCF	1	Vrm1	Vds1 CH A Vds1 CH B Vds1 CH C Vds1 CH D
	2	Vrm2	Vds2 CH A Vds2 CH B Vds2 CH C Vds2 CH D
	3	Vrm3	Vds3 CH A Vds3 CH B Vds3 CH C Vds3 CH D
MFT series 454FT, 504FT, 534FT K-BAR-2000 2440	1	R1	D1
	2	R2	D2
	3	R3	D3
MFT B-Series 454FTB 504FTB 534FTB K-BAR-2000B	1	R1	D1
	2	R2	D2
	3	R3	D3

* The 155 supports two formats of CF, one called CCF and the other VCF. The recommended method with the 155 is CCF and it works as shown in Table AK-2 and matches the MFT line nomenclature as shown. The VCF type is not recommended with the multipoint 155 systems and is not described here.

Correction Factor Menus

The CF menus are found under *Program Mode*, by advancing to “Set Meter X Data”, press **E** to access the X meter of interest. In the 155, X can be 1 to 16 whereas with the MFT and MFT B-series flow transmitters this would be meter 1. The 155 flow computer menus are found in the [360204-6.81](#) summary guide. The 155 supports both a “BIAS” correction factor which is a velocity independent correction factor, just like having one data set and the multiple velocity types described above.

The MFT line and MFT B-Series also have a sensor blockage correction factor SBCF which is base on the probe support diameter, insertion depth and duct area. It is a number < 1.0 to account the area blockage caused by the probe support and sensor window.

MFT B-Series Meter Correction Factors

Once the field calibration process ([CAL-016](#)) is complete, correction factors reviewed with a spreadsheet, it is safe to enter this data into the flow meter. Then the indicated flow reading will match the reference method flow reads resulting in the best absolute accuracy.

Enter *Program Mode*, press **P** using the edit or tech access code, 645321 then press **E**. Advance using the **P** key to the menu:

```
PRESS E TO SET  
METER 1 FLOW
```

Now press **P** to advance to the screen for correction factors starting with:

```
ENTER BIAS CF  
BCF = x.xxxxx
```

This is a velocity independent correction factor which is useful to “tune” the meter without having to re-enter a whole set of correction factors from a field calibration. By typing the value of interest and **E** you can change this setting. The next menu enters the VCF menu area.

```
PRESS E TO SET  
VARIABLE CF
```

Press **P** or **E** to move pass this screen. After this we select the number of correction factor data sets to be used.

```
ENTER # OF FLOW  
DATA SETS
```

Use the **^v** keys or type the number of data sets on the keypad followed by **E**.

```
ENTER FLOW  
DATA SET # 1
```

Again, this is the number of data sets to be used for velocity or flow rate depended correction factors. Enter the number of interest followed by **E** or press **P** to skip to the next menu.

```
R1= X.XXXX FUNIT
```

Here you enter the reference velocity for insertion meters or flow rate for in-line meters followed by the **E** key or press **P** to skip the menu.

```
R1=X.XXXX FUNIT  
D1=X.XXXX FUNIT
```

Next the second line is shown so the velocity or flow rate value on the flow meter can be typed in followed by **E**. Again, pressing **P** will skip the menu without making any changes. The above menu repeats until you have loaded the correction factor table for all data sets.

Lastly, the **C** key can be pressed several times to move up the menus and exit *Program Mode*.

All the correction factors discussed above are multiplicative.
Total CF = SBCF x BCF x VCF.