SCC Inc.

Installation Instructions

Document No. FMC-1100

March 10, 2020

FMC Series

Gas Flow Meter Kit for Burner Commissioning

Product Information

The FMC109-800A gas flow meter kit measures and displays the pressure / temperature compensated instantaneous flow of common fuel gases in standard cubic feet per hour (SCFH). Heat input can also be displayed. Fuel gases include: natural gas, propane, and biogas / digester gas. Air flow can also be measured.

Calibration of the meter can be automatically checked. Yearly re-calibrations are typically not required.

Recommended Installation Tools

1. PTFE tape
2. Tape measure
3. 1-1/2”, 1-1/4”, and 8mm open end wrenches or two 12” crescent wrenches
4. 2.5mm hex key

Components Supplied

Figure 1 shows all of the components that are supplied with the Gas Flow Meter Kit.

Figure 1: Components Included in the Gas Flow Meter Kit

1. Enclosure with touch screen and 120 VAC 5 amp convenience outlet
2. Insertion type flow meter – 1 ½" to 8" schedule 40 pipe
3. Interconnecting cable, 25 feet long
4. Stainless steel packing gland for 3/4" tube, 3/4" NPT connection
5. Probe protector for meter
6. 120 VAC power right angle power cord, 10 feet long, 10A max

Printed instructions and the meter calibration report are also included in the kit.

Installation Procedure

1. The gas flow meter may be mounted in horizontal or vertical piping. The flow meter must be mounted at least 15 pipe diameters downstream of disturbances (elbows, reducers, etc.) and at least 10 pipe diameters upstream of disturbances. See Figure 2 below for the necessary distance of straight pipe upstream and downstream of the meter. If the meter is not mounted per the requirements below, unstable and inaccurate flow readings are likely to result.

   Note: Proper upstream and downstream pipe diameters are critical to achieve accurate and stable flow readings.

   Note: Gas must be dry (non-condensing) – moisture droplets in the flow stream will also cause inaccurate and erratic flow readings.

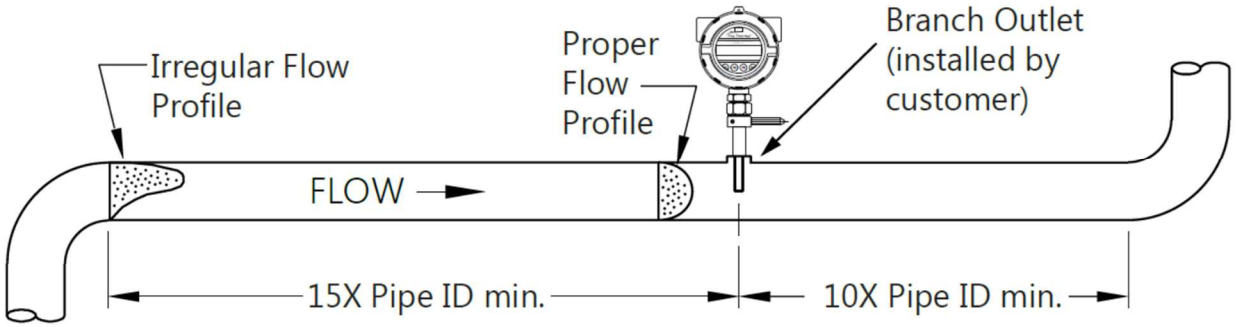


Figure 2: Necessary Amount of Straight Pipe for Mounting Flow Meter

2. Once a suitable location has been found, identify the pipe size and the pipe schedule. With this information, use Table 2 or 3 in Appendix A to verify that the gas velocity through the pipe in this location is less than 25,000 standard feet per minute.

Installation Procedure (continued)

3. Verify that the static pressure in the pipe is less than 150 PSIG and the gas temperature (when flowing) is between -10°F to 250°F.

4. Verify that the gas piping into which the meter is going to be inserted is depressurized. If not, close the upstream gas valve and bleed off any residual trapped gas in a safe manner. If welding on the pipe is to be done, the piping must be thoroughly purged with an inert gas.

5. If a 3/4" NPT or larger half coupling is not available in a suitable location, one will need to be welded onto the pipe with a 13/16" (0.813") or larger hole drilled through the pipe wall in the center of the half coupling. The coupling must be parallel to the pipe centerline, as shown in Figure 3, so that the probe can be inserted into the center of the pipe at a later step. The pipe should look similar to Figure 4 before the packing gland and the meter probe are installed.

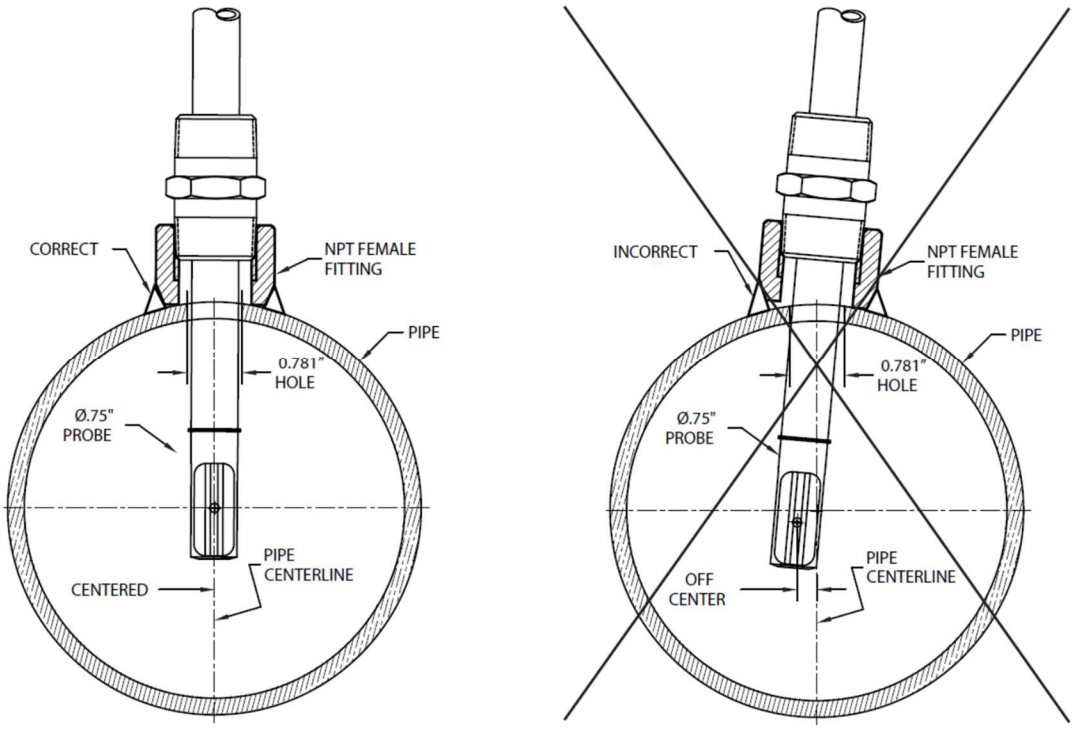


Figure 3: Mounting of a 3/4" NPT Half Coupling on the Pipe Centerline

Installation Procedure (continued)

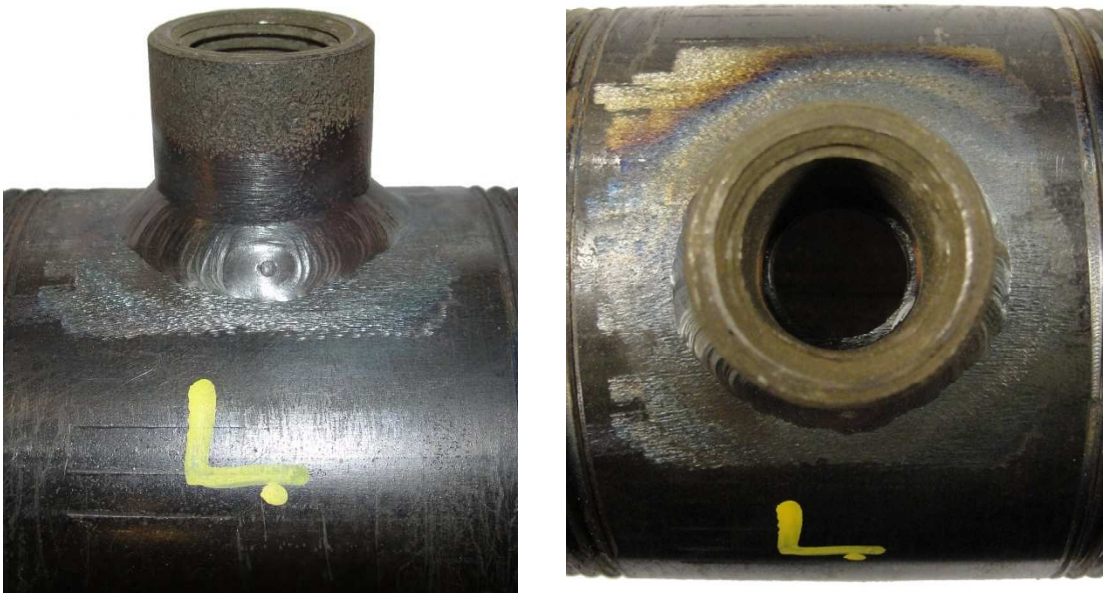


Figure 4: 3/4" NPT Half Coupling Welded to Pipe with 13/16" Hole Drilled Through Center

Notes:

- **One method to ensure that the 13/16" or larger hole is concentric with the 3/4" female NPT thread is to use a 2.5" long schedule 40 pipe nipple as a drill bit guide. A 53/64" (0.828") drill bit fits snugly inside the 3/4" Schedule 40 pipe nipple. This drill bit can be used to accurately mark the center of the thru hole so a smaller, concentric pilot hole can be drilled. If using this method, the half coupling must be welded to the pipe before the hole is drilled.**
- **Inside of thru hole must be burr free – burrs can cause a disruption in the flow.**
- **A larger half coupling with a threaded reducing bushing can also be used if desired.**

6. Screw the packing gland into the 3/4" NPT half coupling and tighten with the 1-1/4" open end wrench (or crescent wrench). PTFE tape should be used to seal the NPT threads of the packing gland.

Installation Procedure (continued)

7. Insert the meter sensing tube into the packing gland. Using Table 1 and Figure 5, center the meter's sensing element in the pipe by setting distance "X" (distance from the outer diameter of the pipe to the bottom of the pointer edge). This can be done carefully with a tape measure. Ensure that the pointer on the flow meter is pointing in the direction of flow.

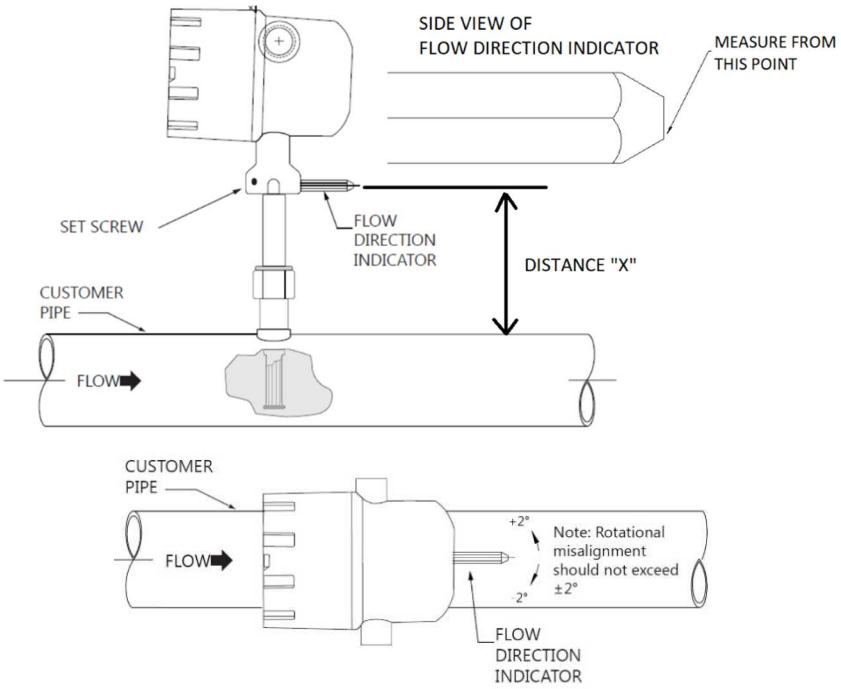


Figure 5: Meter Inserted into Pipe

Table 1: Meter Insertion Distance

Pipe Size (SCH40 & 80)	Distance "X"
1-1/2"	8.55"
2"	8.31"
2-1/2"	8.06"
3"	7.75"
4"	7.25"
6"	6.19"
8"	5.19"

Note: To get the insertion distance for other pipe outer diameters, simply divide the outer diameter of the pipe by 2 and subtract this number from 9.5".

Installation Procedure (continued)

8. After the meter is inserted to the correct depth with the pointer in the direction of flow (+/- 2 degrees), tighten the packing gland nut with the 1-1/2" open end wrench (or crescent wrench). Use the 1-1/4" open end wrench (or the second crescent wrench) as a back-up wrench on the packing gland. Tighten to approximately 55 ft*lb of torque. This will cause the Viton sealant in the packing gland to compress around the meter's sensing tube.

   Note: To rotate the housing of the flow meter relative to the flow direction indicator, loosen the set screw and unscrew (remove) the flow direction indicator. Rotate the housing +/- 90 degrees or 180 degrees. Do not spin the housing around completely (360 degrees repeatedly) due to wires connecting the probe to the housing. Re-install the flow indicator and then tighten set screw.

9. Connect the interconnecting cable to the flow meter and to the enclosure. The male end of the cable connects to the enclosure and the female end connects to the flow meter.

10. Plug the power cord into the side of the enclosure. The meter and the remote display should power up after the power cord is plugged in. After this step, the meter and enclosure should look like Figure 6.

Figure 6: Flow Meter Connected to Remote Display

Installation Procedure (continued)

11. Plug in the flow meter's power cord to 120 VAC power. The display on the flow meter and the touch screen should power up. After both have initialized (booted), the configuration screen should look like Figure 7 below.

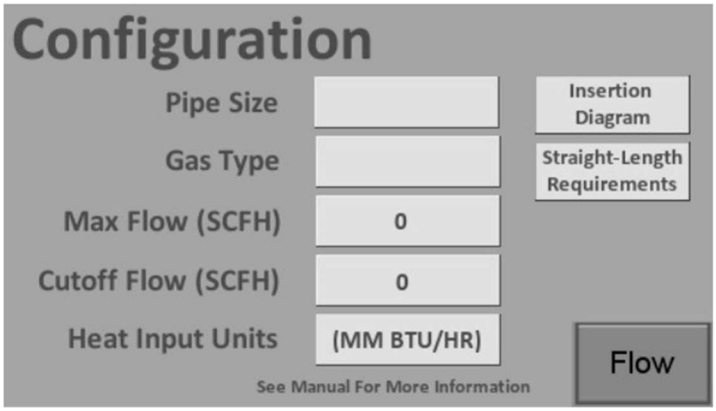


Figure 7: Configuration Screen on Meter Power-up

12. Tap the button beside "Pipe Size". The following menu should pop-up as shown in Figure 8 below.

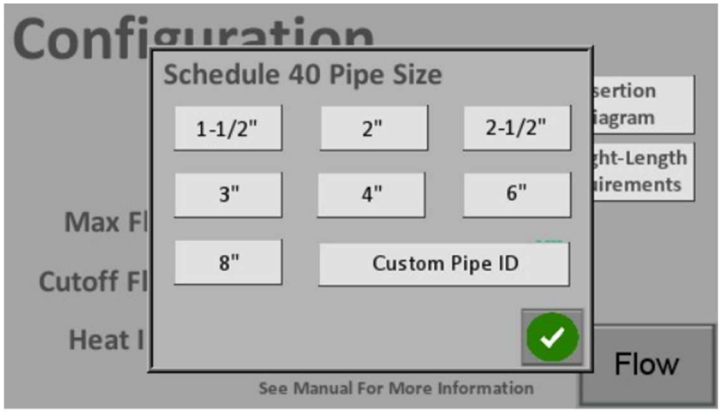


Figure 8: Schedule 40 Pipe Size Pop-up Window

13. Select the correct trade size of Schedule 40 pipe. The pipe I.D. associated with these trade sizes will be entered into the meter. If a Schedule 80 pipe or some other odd size pipe is encountered and the I.D. of the pipe is known, this can be entered in by using the "Custom Pipe ID" button. Note that the I.D. of some common sizes of Schedule 80 pipe can be found in Appendix A.

    Note: For custom pipe I.D. the minimum value is 1.5" and the maximum value is 10".

Installation Procedure (continued)

14. Next, tap the button beside “Gas Type”. Common fuel gases can be selected, and a custom heating value for that gas can be entered if known. In Figure 9 below, “Natural Gas” has been selected, and a standard heating value of 1000 BTU / SCF has been automatically entered. If the “Heating Value” button is tapped, a different natural gas heating value can then be entered.

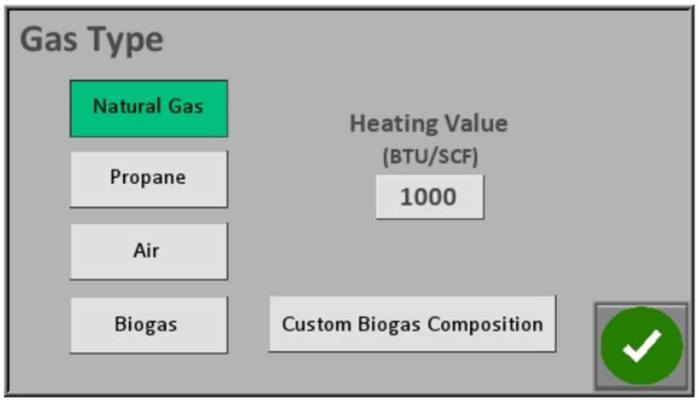


Figure 9: Gas Type Pop-up Window

Note: Always select the proper fuel gas since this affects the gas density calculations in the flow meter. The heating value is only used to show the burner’s heat input, and will not adjust the gas density.

Installation Procedure (continued)

15. If biogas / digester gas is being used, a custom biogas composition can be entered. To do this, tap the “Custom Biogas Composition” button and the screen shown below in Figure 10 should appear.

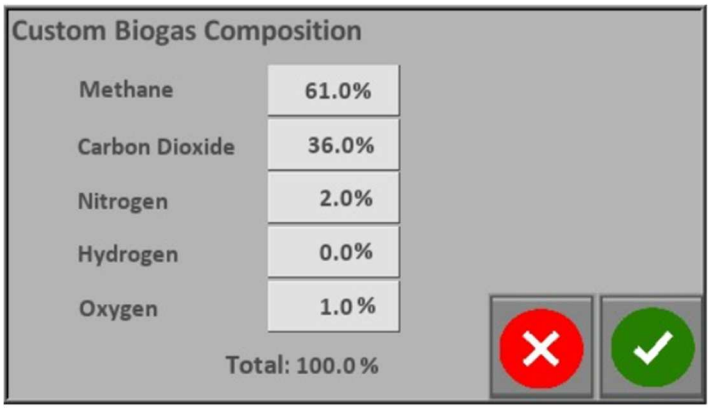


Figure 10: Custom Biogas Pop-up Window

16. If a custom biogas composition is entered, all the components must add up to 100% or the new composition will not be accepted. The red “X” on the screen can be used to exit the screen and use the default biogas composition.

17. After the “Pipe Size” and “Gas Type” are entered the screen should appear as is seen in Figure 11 below. The “Max Flow” and “Cutoff Flow” are auto filled based on the pipe size that was previously selected.

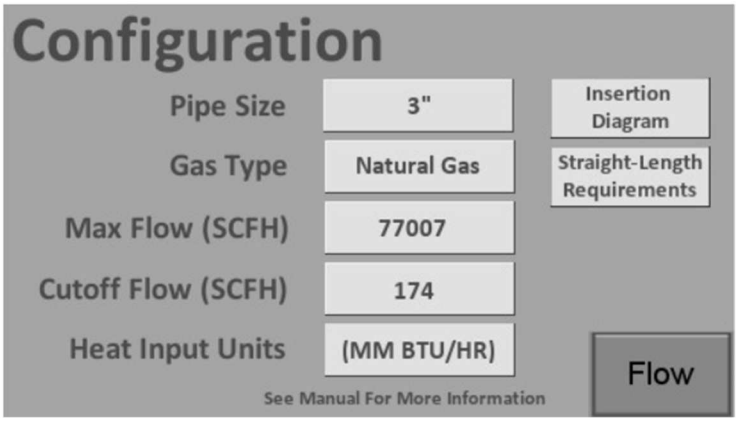


Figure 11: Completed Configuration Screen

Installation Procedure (continued)

18. The “Max Flow” button is auto filled based on the maximum gas velocity for the meter which is 25,000 Standard Feet Per Minute (SFPM). This can also be adjusted to a lower number that is closer to the actual flow in the application, if desired. The “Cutoff Flow” is the flow at which the meter display will drop to 0 SCFH. This can also be adjusted to a higher or lower number if desired.

    Note: The “Max Flow” setting and the “Cutoff Flow” setting have no impact on the calibration of the meter. If the value for “Max Flow” is exceeded, a “Max Flow Exceeded” warning will pop-up on the flow screen.

19. At this point, the meter settings should be correct for the application. For convenience, the insertion distance for the selected pipe size is also available on the touch screen. To access this screen, tap the “Insertion Diagram” button. See Figure 12 below that displays the correct insertion distance for 3” pipe.

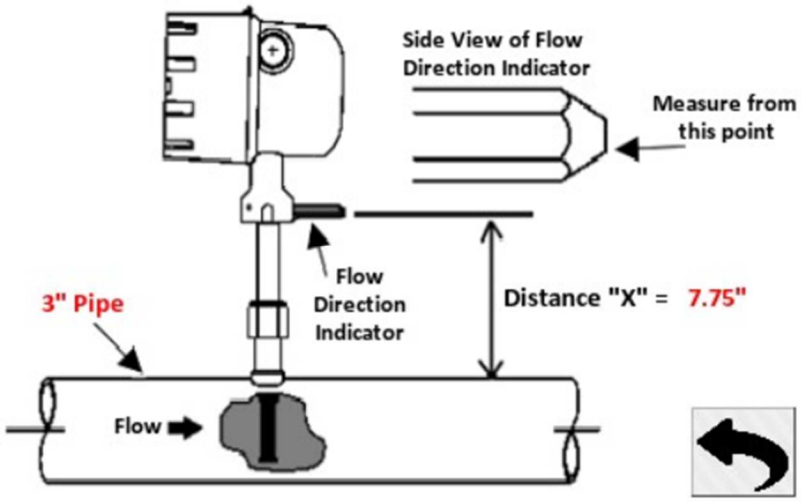


Figure 12: Meter Insertion Distance (3 inch pipe shown)

Note: Schedule 40 and Schedule 80 pipe have the same O.D. so the insertion distance is valid for both schedules of pipe. For a custom pipe O.D. distance “X” can be found by simply dividing the outer diameter of the pipe by 2 and subtracting this number from 9.5”.

20. For convenience, a diagram showing straight length requirements of the meter is also provided. To view this, tap the “Straight Length Requirements” button on the touch screen. This screen should look identical to Figure 2 in this literature.

Installation Procedure (continued)

21. The “Heat Input Units” can also be selected. Choices are thousands of BTU per hour (M BTU / HR) or millions of BTU per hour (MM BTU / HR).

22. Now that the configuration, the insertion distance, and the straight length requirements of the meter are verified the meter is ready to use. Tap the “Flow” button to access the flow screen.

    Note: The Modbus points for the configuration are written to the meter when the “Flow” button is tapped.

23. The flow screen is shown in Figure 13 below. Flow in SCFH is shown in white at the top, and the heat input into the system is shown in red at the bottom. The heat input is calculated using the flow and multiplying this number by the heating value and adjusting for the appropriate heat input unit. Critical meter settings are read back from the meter’s Modbus registers and are displayed at the bottom of the screen.

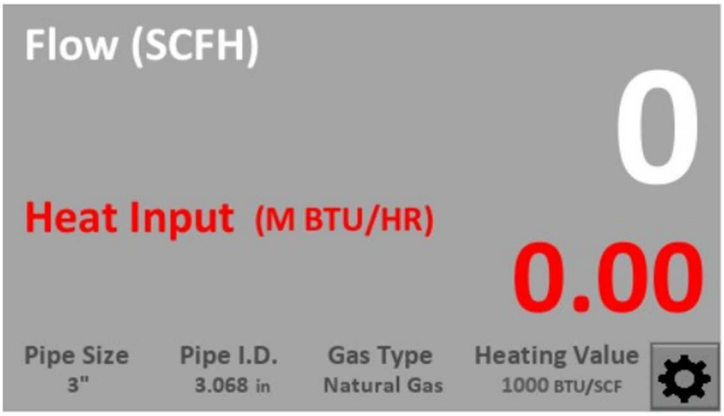


Figure 13: Flow Screen – Normal Operation

24. A convenience outlet is provided on the side of the enclosure for up to 5A of load. This is typically used to plug in an external combustion analyzer or a laptop computer. The remote display can also be hung by eyelets provided on the back of the enclosure. Strong magnets with hooks (not provided) can be used to hang the enclosure on the side of a steel skinned boiler or on a steel control panel.

Installation Procedure (continued)

25. After use, remove all power from the enclosure prior to de-pressurizing the gas piping. Remove the flow meter and packing gland. Plug the now open half coupling. Place the flow meter and accessories back into the plastic case. When all components are put back into the case, the flow meter kit should appear as shown in Figure 14.

Figure 14: Flow Meter Kit Packaged in Case

Calibration Validation Procedure

The Fox Thermal FT1 has the ability to validate its own calibration, thus significantly reducing the number of re-calibrations over the life of the meter. This calibration validation is referred to as Zero CAL-CHECK®, and the procedure to do this is outlined below.

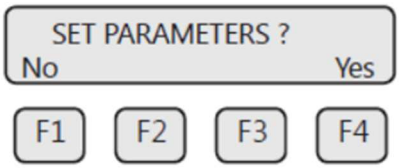
1. Visually inspect the meter's probe for damage and / or significant dirt build up. The probe should look like Figure 15.

Figure 15: Clean Undamaged Probe

2. The gas flow meter probe must be in an area of zero gas velocity for the calibration validation. It is recommended to remove the meter from the pipe and install the meter probe protector over the probe to ensure zero gas velocity across the probe.

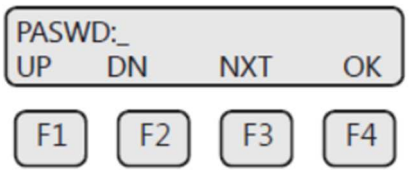
3. The meter cover must be unscrewed, and buttons F1 thru F4 must be used to navigate down through the menus to reach the Zero CAL-CHECK®.

4. With the screen in normal running mode, press the F1 key and the following screen should appear:

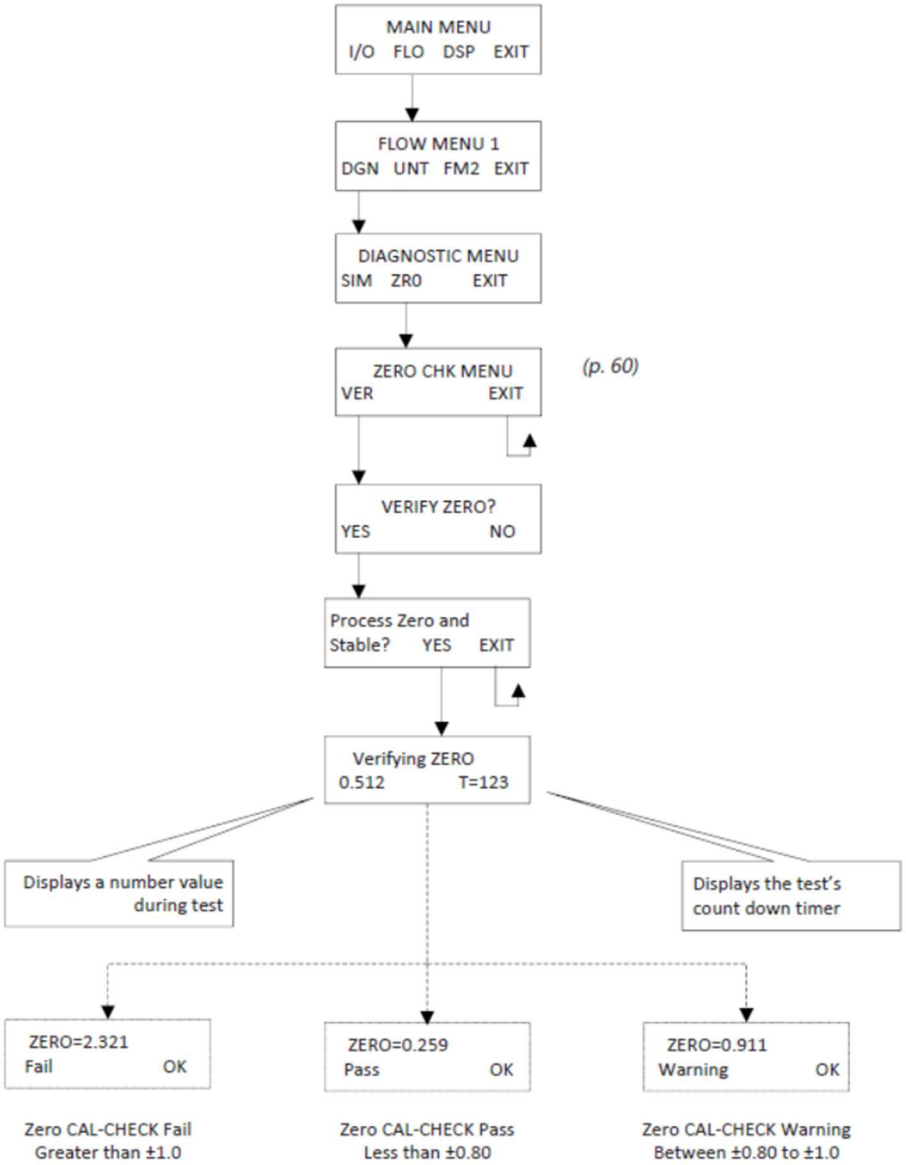


Calibration Validation Procedure (continued)

5. Press Yes (F4) and the next screen will prompt the user to enter a password. The default password is “1234”. Press OK (F4) after the password is entered



6. After this, follow the menu path below to execute the Zero CAL-CHECK®



Calibration Validation Procedure (continued)

7. If the result of “Warning” or “Fail” is displayed, clean the sensor with a soft bristle (non-metallic) brush with water or denatured alcohol. Let the sensor dry thoroughly (at least 10 minutes), re-install the probe cover, and run the calibration validation again.

8. If the calibration still fails, contact your salesperson. The meter will need to be sent back for repair.

Appendix A

Table 2: Maximum and Minimum Flow Rates by Pipe Size – Schedule 40

Pipe Size (in)	Pipe I.D. SCH 40 (in)	Min Flow (SCFH)	Max Standard Velocity (SFPM)	Max Flow (SCFH)	Max Boiler Output (BHP) [1]	Max Boiler Output (LB/HR) [2]
1.5	1.61	48	25000	21207	538	18195
2	2.07	79		34954	888	29990
2.5	2.47	113		49872	1266	42790
3	3.07	174		77007	1955	66070
4	4.03	300		132607	3367	113774
6	6.07	681		300940	7641	258200
8	7.98	1179		520984	13229	446993

Table 3: Maximum and Minimum Flow Rates by Pipe Size – Schedule 80

Pipe Size (in)	Pipe I.D. SCH 80 (in)	Min Flow (SCFH)	Max Standard Velocity (SFPM)	Max Flow (SCFH)	Max Boiler Output (BHP) [1]	Max Boiler Output (LB/HR) [2]
1.5	1.50	42	25000	18408	467	15793
2	1.94	70		30759	781	26391
2.5	2.32	100		44149	1121	37879
3	2.90	156		68804	1747	59033
4	3.83	271		119759	3041	102751
6	5.76	614		271434	6892	232884
8	7.62	1075		475038	12062	407573

Notes:

1. Boiler Horsepower numbers assume a heating value of 1000 BTU / SCF and a boiler efficiency of 85%.
2. Steam flow numbers assume 230^{o}F feed water and 100 PSIG steam.

Appendix A (continued)

Table 4: Schedule 40 Pipe Velocities and Flows

STANDARD VELOCITY			1 -1/2"		2"		2 -1/2"		3"	
			FLOW		FLOW		FLOW		FLOW	
STD FT/SEC	STD FT/MIN	STD FT/HR	GAS SCFH	STEAM BHP	GAS SCFH	STEAM BHP	GAS SCFH	STEAM BHP	GAS SCFH	STEAM BHP
0.0	**0**	0	0	0	0	0	0	0	0	0
16.7	**1000**	60000	848	22	1398	36	1995	51	3080	78
33.3	**2000**	120000	1697	43	2796	71	3990	101	6161	156
50.0	**3000**	180000	2545	65	4195	107	5985	152	9241	235
66.7	**4000**	240000	3393	86	5593	142	7980	203	12321	313
83.3	**5000**	300000	4241	108	6991	178	9974	253	15401	391
100.0	**6000**	360000	5090	129	8389	213	11969	304	18482	469
116.7	**7000**	420000	5938	151	9787	249	13964	355	21562	548
133.3	**8000**	480000	6786	172	11185	284	15959	405	24642	626
150.0	**9000**	540000	7634	194	12584	320	17954	456	27722	704
166.7	**10000**	600000	8483	215	13982	355	19949	507	30803	782
183.3	**11000**	660000	9331	237	15380	391	21944	557	33883	860
200.0	**12000**	720000	10179	258	16778	426	23939	608	36963	939
216.7	**13000**	780000	11027	280	18176	462	25934	659	40044	1017
233.3	**14000**	840000	11876	302	19574	497	27929	709	43124	1095
250.0	**15000**	900000	12724	323	20973	533	29923	760	46204	1173
266.7	**16000**	960000	13572	345	22371	568	31918	810	49284	1251
283.3	**17000**	1020000	14420	366	23769	604	33913	861	52365	1330
300.0	**18000**	1080000	15269	388	25167	639	35908	912	55445	1408
316.7	**19000**	1140000	16117	409	26565	675	37903	962	58525	1486
333.3	**20000**	1200000	16965	431	27963	710	39898	1013	61605	1564
350.0	**21000**	1260000	17814	452	29362	746	41893	1064	64686	1643
366.7	**22000**	1320000	18662	474	30760	781	43888	1114	67766	1721
383.3	**23000**	1380000	19510	495	32158	817	45883	1165	70846	1799
400.0	**24000**	1440000	20358	517	33556	852	47878	1216	73927	1877
416.7	**25000**	1500000	21207	538	34954	888	49872	1266	77007	1955

Note:
Boiler Horsepower numbers assume a natural gas heating value of 1000 BTU / SCF and a boiler efficiency of 85%.

Appendix A (continued)

Table 4: Schedule 40 Pipe Velocities and Flows (continued)

STANDARD VELOCITY			4"		6"		8"	
			FLOW		FLOW		FLOW	
STD FT/SEC	STD FT/MIN	STD FT/HR	GAS SCFH	STEAM BHP	GAS SCFH	STEAM BHP	GAS SCFH	STEAM BHP
0.0	**0**	0	0	0	0	0	0	0
16.7	**1000**	60000	5304	135	12038	306	20839	529
33.3	**2000**	120000	10609	269	24075	611	41679	1058
50.0	**3000**	180000	15913	404	36113	917	62518	1587
66.7	**4000**	240000	21217	539	48150	1223	83357	2117
83.3	**5000**	300000	26521	673	60188	1528	104197	2646
100.0	**6000**	360000	31826	808	72226	1834	125036	3175
116.7	**7000**	420000	37130	943	84263	2140	145876	3704
133.3	**8000**	480000	42434	1077	96301	2445	166715	4233
150.0	**9000**	540000	47738	1212	108338	2751	187554	4762
166.7	**10000**	600000	53043	1347	120376	3057	208394	5292
183.3	**11000**	660000	58347	1482	132414	3362	229233	5821
200.0	**12000**	720000	63651	1616	144451	3668	250072	6350
216.7	**13000**	780000	68956	1751	156489	3974	270912	6879
233.3	**14000**	840000	74260	1886	168527	4279	291751	7408
250.0	**15000**	900000	79564	2020	180564	4585	312590	7937
266.7	**16000**	960000	84868	2155	192602	4891	333430	8466
283.3	**17000**	1020000	90173	2290	204639	5196	354269	8996
300.0	**18000**	1080000	95477	2424	216677	5502	375109	9525
316.7	**19000**	1140000	100781	2559	228715	5808	395948	10054
333.3	**20000**	1200000	106086	2694	240752	6113	416787	10583
350.0	**21000**	1260000	111390	2828	252790	6419	437627	11112
366.7	**22000**	1320000	116694	2963	264827	6725	458466	11641
383.3	**23000**	1380000	121998	3098	276865	7030	479305	12171
400.0	**24000**	1440000	127303	3232	288903	7336	500145	12700
416.7	**25000**	1500000	132607	3367	300940	7641	520984	13229

Note:
Boiler Horsepower numbers assume a natural gas heating value of 1000 BTU / SCF and a boiler efficiency of 85%.

Appendix A (continued)

Table 5: Schedule 80 Pipe Velocities and Flows

STANDARD VELOCITY			1 -1/2"		2"		2 -1/2"		3"	
			FLOW		FLOW		FLOW		FLOW	
STD FT/SEC	STD FT/MIN	STD FT/HR	GAS SCFH	STEAM BHP	GAS SCFH	STEAM BHP	GAS SCFH	STEAM BHP	GAS SCFH	STEAM BHP
0.0	**0**	0	0	0	0	0	0	0	0	0
16.7	**1000**	60000	736	19	1230	31	1766	45	2752	70
33.3	**2000**	120000	1473	37	2461	62	3532	90	5504	140
50.0	**3000**	180000	2209	56	3691	94	5298	135	8256	210
66.7	**4000**	240000	2945	75	4921	125	7064	179	11009	280
83.3	**5000**	300000	3682	93	6152	156	8830	224	13761	349
100.0	**6000**	360000	4418	112	7382	187	10596	269	16513	419
116.7	**7000**	420000	5154	131	8613	219	12362	314	19265	489
133.3	**8000**	480000	5890	150	9843	250	14128	359	22017	559
150.0	**9000**	540000	6627	168	11073	281	15894	404	24769	629
166.7	**10000**	600000	7363	187	12304	312	17659	448	27522	699
183.3	**11000**	660000	8099	206	13534	344	19425	493	30274	769
200.0	**12000**	720000	8836	224	14764	375	21191	538	33026	839
216.7	**13000**	780000	9572	243	15995	406	22957	583	35778	908
233.3	**14000**	840000	10308	262	17225	437	24723	628	38530	978
250.0	**15000**	900000	11045	280	18455	469	26489	673	41282	1048
266.7	**16000**	960000	11781	299	19686	500	28255	717	44035	1118
283.3	**17000**	1020000	12517	318	20916	531	30021	762	46787	1188
300.0	**18000**	1080000	13254	337	22147	562	31787	807	49539	1258
316.7	**19000**	1140000	13990	355	23377	594	33553	852	52291	1328
333.3	**20000**	1200000	14726	374	24607	625	35319	897	55043	1398
350.0	**21000**	1260000	15463	393	25838	656	37085	942	57795	1468
366.7	**22000**	1320000	16199	411	27068	687	38851	987	60548	1537
383.3	**23000**	1380000	16935	430	28298	719	40617	1031	63300	1607
400.0	**24000**	1440000	17671	449	29529	750	42383	1076	66052	1677
416.7	**25000**	1500000	18408	467	30759	781	44149	1121	68804	1747

Note:
Boiler Horsepower numbers assume a natural gas heating value of 1000 BTU / SCF and a boiler efficiency of 85%.

Appendix A (continued)

Table 5: Schedule 80 Pipe Velocities and Flows (continued)

STANDARD VELOCITY			4"		6"		8"	
			FLOW		FLOW		FLOW	
STD FT/SEC	STD FT/MIN	STD FT/HR	GAS SCFH	STEAM BHP	GAS SCFH	STEAM BHP	GAS SCFH	STEAM BHP
0.0	**0**	0	0	0	0	0	0	0
16.7	**1000**	60000	4790	122	10857	276	19002	482
33.3	**2000**	120000	9581	243	21715	551	38003	965
50.0	**3000**	180000	14371	365	32572	827	57005	1447
66.7	**4000**	240000	19161	487	43429	1103	76006	1930
83.3	**5000**	300000	23952	608	54287	1378	95008	2412
100.0	**6000**	360000	28742	730	65144	1654	114009	2895
116.7	**7000**	420000	33533	851	76001	1930	133011	3377
133.3	**8000**	480000	38323	973	86859	2206	152012	3860
150.0	**9000**	540000	43113	1095	97716	2481	171014	4342
166.7	**10000**	600000	47904	1216	108573	2757	190015	4825
183.3	**11000**	660000	52694	1338	119431	3033	209017	5307
200.0	**12000**	720000	57484	1460	130288	3308	228018	5790
216.7	**13000**	780000	62275	1581	141145	3584	247020	6272
233.3	**14000**	840000	67065	1703	152003	3860	266021	6755
250.0	**15000**	900000	71855	1825	162860	4135	285023	7237
266.7	**16000**	960000	76646	1946	173718	4411	304024	7720
283.3	**17000**	1020000	81436	2068	184575	4687	323026	8202
300.0	**18000**	1080000	86227	2189	195432	4962	342028	8685
316.7	**19000**	1140000	91017	2311	206290	5238	361029	9167
333.3	**20000**	1200000	95807	2433	217147	5514	380031	9650
350.0	**21000**	1260000	100598	2554	228004	5790	399032	10132
366.7	**22000**	1320000	105388	2676	238862	6065	418034	10615
383.3	**23000**	1380000	110178	2798	249719	6341	437035	11097
400.0	**24000**	1440000	114969	2919	260576	6617	456037	11580
416.7	**25000**	1500000	119759	3041	271434	6892	475038	12062

Note:
Boiler Horsepower numbers assume a natural gas heating value of 1000 BTU / SCF and a boiler efficiency of 85%.