

ANNUBAR FLOW CALCULATION PROGRAM
(For the FloBoss 103)

User Manual
(QER 04Q019)

Form A6159
September 2004

Revision Tracking Sheet

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This manual may be revised from time to time to incorporate new or updated information. The revision level of each page is indicated at the bottom of the page opposite of the page number. A change in revision level to any page also changes the date of the manual which appears on the front cover. Listed below is the revision level of each page that corresponds to the front cover date.

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1 INTRODUCTION

The Annubar Flow Calculation User Program (QER 04Q019), Version 1.01, is designed for the FloBoss™ 103 Flow Computer. The program allows a FloBoss 103 to calculate flow rates, integrate volumes, and archive historical values for installations implementing an Annubar end element. The program supports both the Annubar Diamond II and Annubar 485 “T-shaped” element types. The program provides flow calculations for gas, steam/water and fluid applications in either Metric or Imperial units.

The Annubar Flow Calculation Program is compatible with FloBoss 103, firmware version 2.00 and greater. The user program is downloaded and configured in the FloBoss 103 with ROCLINK™ 800 Configuration Software (Version 1.30 or greater).

The components of 04Q019 are:

- ◆ The Annubar Flow Calculation user program that loads into FloBoss memory to provide support for Annubar applications.
- ◆ This manual, Form A6159.

This manual assumes that the user is familiar with the FloBoss unit and its configuration. For more information, refer to the *FloBoss 103 Flow Manager Instruction Manual* (Form A6114) and *ROCLINK 800 Configuration Software User Manual* (Form A6121).

2 OPERATION

The FloBoss 103 reads flow inputs (differential pressure, temperature, and static pressure) once every second. The Annubar instantaneous flow rate calculation is performed once a second by the user program. Configuration is accomplished through the standard meter run configuration display and Annubar flow calculation user display.

The program itself does not perform gas or fluid property calculations. Gas properties can be obtained from FloBoss firmware, using AGA8 1992 standards, or from a separate user program installed in the FloBoss. The gas calculation requires compressibility, gas correction factors, and heating value to be provided. For steam, water, or fluid applications, a separate user program must be installed to calculate and provide the necessary fluid properties, including density and heating value.

The user program accumulates volume (or mass) and energy and provides the accumulations to the FloBoss 103 for archival into the periodic and daily databases. Values saved to the historical database will be in the units shown below.

	<u>Volume/Mass Units</u>	<u>Energy Units</u>
Gas volume calc	MCF or km ³	MMBTU or GJoules
Mass rate calc	1000 lb _m or 1000 kg	MMBTU or GJoules

2.1 Annubar Flow Calculations

The purpose of the Annubar Flow Calculation program is to provide an instantaneous flow rate for Annubar installations. In gas applications, the program calculates an instantaneous volume flow rate. The instantaneous rate is corrected to base conditions and provided in ft³/hour or m³/hour. In steam, water and fluid applications, the program calculates an instantaneous mass flow rate in lb_m/hour or kg/hour. Equations used for the gas (volume) and mass calculations are shown below.

Gas volume equation

$$Q_b = F_{na} * K * D^2 * Y_a * F_{pb} * F_{tb} * F_{tf} * F_g * F_{pv} * F_{aa} * \text{sqrt}(h_w * P_f)$$

Where:

Q_b = gas flow rate at base conditions in ft³/hour or m³/hour

F_{na} = Units conversion factor

K = Annubar flow coefficient (calculated by Annubar user program or entered by user)

D = Pipe diameter (ID) in inches or millimeters

Y_a = Gas expansion factor (calculated by Annubar user program)

F_{pb} = Base pressure factor (provided by FB103 firmware or other user program)

F_{tb} = Base temperature factor (provided by FB103 firmware or other user program)

F_{tf} = Flowing temperature factor (provided by FB103 firmware or other user program)

F_g = Specific gravity factor (provided by FB103 firmware or other user program)

F_{pv} = Compressibility factor (provided by FB103 firmware or other user program)

F_{aa} = Thermal expansion factor (calculated by Annubar user program)

h_w = Differential pressure in Inches H₂O or kPa

P_f = Static (flowing) pressure in PSIA or kPa

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Mass rate equation

$$Q_m = F_{na} * K * D^2 * Y_a * F_{aa} * \text{sqrt}(h_w * p_f)$$

Where:

Q_m = mass flow rate in lb_m/hour or kg/hour

F_{na} = Units conversion factor

K = Annubar flow coefficient (calculated by Annubar user program or entered by user)

D = Pipe diameter (ID) in inches or millimeters

Y_a = Gas expansion factor (calculated by Annubar user program, always 1.0 for liquids)

F_{aa} = Thermal expansion factor (calculated by Annubar user program)

h_w = Differential pressure in Inches H₂O or kPa

p_f = Flowing density in lb/ft³ or kg/m³ (provided by other user program or entered by user)

3 DOWNLOADING THE ANNUBAR FLOW CALCULATION PROGRAM

- ❖ **NOTE:** A PC-compatible computer must be connected to the Operator Interface port of the FloBoss 103 before downloading is started, and RAM must be available in the intended download area.

3.1 Program Download Requirements

The Annubar Flow Calculation program is downloaded to, and then run from Flash and RAM memory in the FloBoss 103. The following information shows the requirements for downloading and running the software (04Q019):

The user program is downloaded and configured in the FloBoss 103 with ROCLINK™ 800 Configuration Software (Version 1.30 or greater). The Annubar Flow Calculation Program is compatible with FloBoss 103, firmware version 2.00 and greater.

For information on viewing the memory allocation of user programs loaded in the FloBoss, refer to the *ROCLINK 800 Configuration Software User Manual* (Form A6121).

The Annubar flow calculation downloadable program name and information is shown below.

<u>File Name</u>	<u>ROC Type</u>	<u>Task</u>	<u>Code</u>	<u>Data</u>
FB103_ANNUBAR.BIN	FloBoss 103	User 1	790000	46C000

3.2 Program Download Procedure

This section provides instructions for installing the program into FloBoss memory. Make sure to read Section 3.1 of this manual for program and memory requirements.

To download the program using ROCLINK software:

1. **Connect** the FloBoss to your computer through the **LOI** port. Log on to ROCLINK 800 software.
2. Select ROCLINK > Utilities > **User Program Administrator**.
3. Press the **Browse** button in the Download User Program File area of the screen. See *Figure 1*.
4. The Open File dialog box appears as shown in Figure 2. This display lists the names of all the files that have the .bin extension and are located in the default Drive and Directory. Use the mouse or the Up Arrow (↑) and Down Arrow (↓) to select the desired file in the Files list. You may change the path or location using the Directory/Drive field.

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- When the Annubar Flow Calculation program appears in the **File Name** field, select the program and press **Open**.
- Press the **Download** or **Download & Start** button in the **User Program Administrator Box** to begin loading the program.

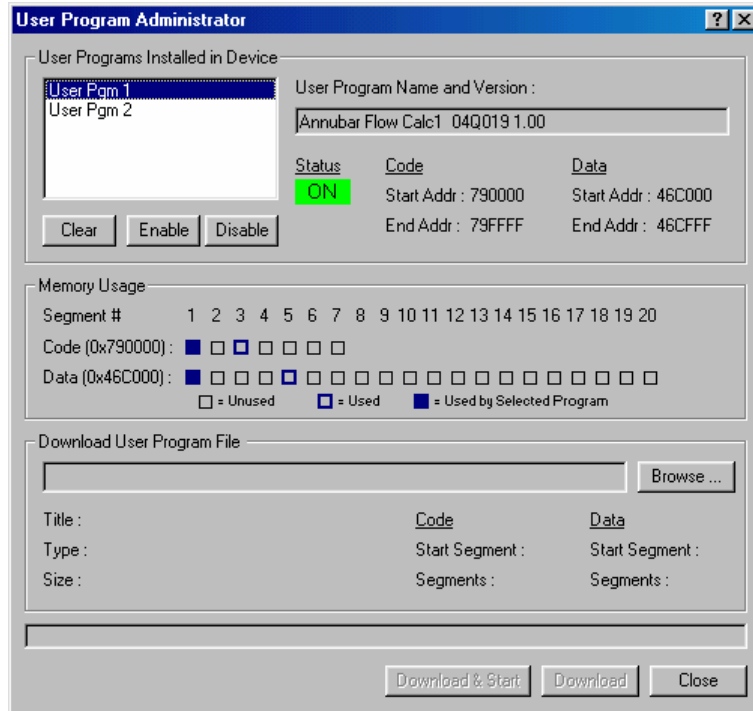


Figure 1. User Program Administrator Box

When the program has been downloaded, a record is created in the Event Log. The user program may be left in an OFF state after download. Prior to configuring operation of the program, as described in Section 4, the program must be turned ON. The program is turned ON from the user program administration window by selecting the **Enable** button.

Refer to the *ROCLINK 800 Configuration Software User Manual* (Form A6121) for additional information concerning User Programs.

4 CONFIGURATION

4.1 Meter Setup Configuration

After the user program is loaded (see Section 3), configure the Annubar meter run using ROCLINK 800 Configuration Software. A portion of the configuration is accomplished through standard meter setup screens provided by ROCLINK 800 software.

The following parameters should be verified and, if necessary, altered in the meter setup configuration:

- Go to the ROC > **Information** screen. The default Units selected will be US. The user program will permit US or Metric units.
- Go to the General tab of the Meter > **Setup** screen. The **Orifice**, **AGA** and **1992** radio buttons should be selected. Verify all the Meter Setup parameters (including pipe diameter, input point definitions, gas composition, compressibility method, base conditions and absolute/gauge tap type).
- Go to the Configure > **History Points** screen. The first eight points are pre-defined. Typical Annubar applications will utilize these eight points. The user may configure others if the application requires.

4.2 Annubar Flow Calculation User Point Configuration

The Annubar application is configured through a user-defined display created by the user program. It is accessed either from Configure menu > User Data > **Annubar Flow Calc** or from the Configuration Tree Menu. See *Figure 2*.

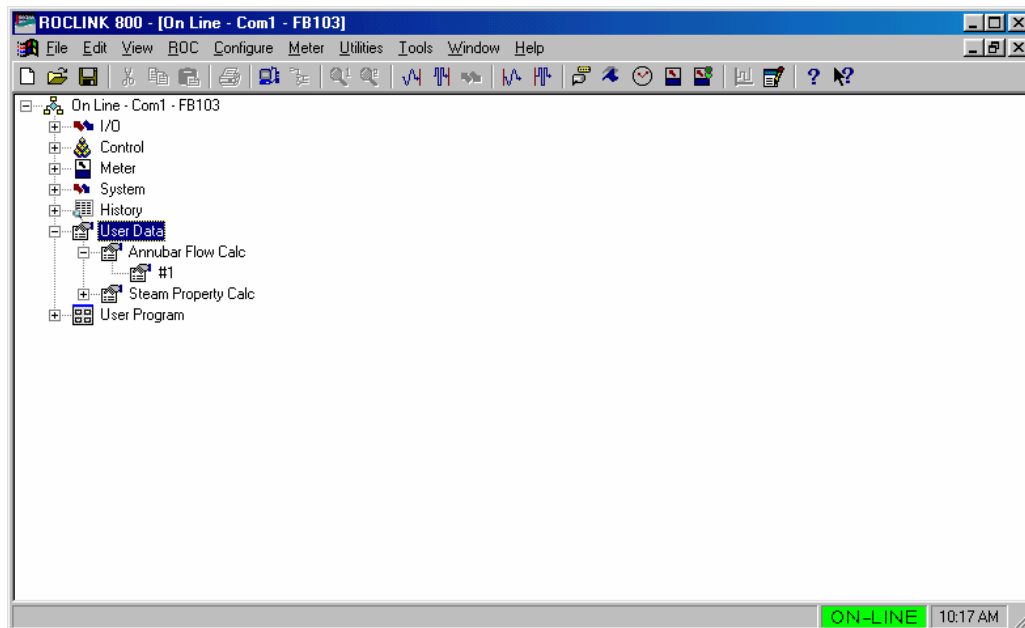


Figure 2. Configuration Tree Menu

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Selecting **Annubar Flow Calc** opens the user program point display. This display provides an interface for setting and monitoring parameters specific to the Annubar flow calculation program. See *Figure 3*.

Figure 3. Annubar Flow User Point Display

The fields with white backgrounds are configurable parameters on this user display. The remaining fields are for display purposes only.

- ❖ **NOTE:** If the user desires all the configuration to be restored and the user program to be turned on automatically after a Cold Start, then select the **Save Configuration** option on the **ROC > Flags** screen after configuring the Meter Setup and Annubar Flow Calc User Point.

Point Number will always be “1”, as the FloBoss 103 permits only one meter run.

A value of “1” in the **Calc Enable** field enables the Annubar flow calculation for the meter run. A “0” value allows standard AGA3 calculation in FloBoss 103 firmware to execute for the meter run.

Softpoint Enable: This field allows the user to define a softpoint number (1-16) to which current input and calculated values will be saved. Some host devices cannot read user-defined point types. In these cases, the current data can be copied to softpoint parameters where it can be accessed by the host device. A value of “0” in this field disables the copy to a softpoint. A value of “1” to “16” identifies the logical of a softpoint to which information is written (once a second). Following is a table showing the data values written to a softpoint when write to softpoint is enabled.

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Softpoint Parameter	Data Value	Softpoint Parameter	Data Value
Data 1	Annubar Coefficient (K)	Data 10	Volume Rate (per day)
Data 2	Flowing Density	Data 11	Energy Rate (per day)
Data 3	Thermal Expansion Factor (F_{aa})	Data 12	Calculation Period
Data 4	Pipe Diameter at Temperature	Data 13	Expansion Factor (F_a)
Data 5	Annubar Probe Diameter at Temp	Data 14	Base Pressure Factor (F_{pb})
Data 6	Current Differential Pressure	Data 15	Base Temperature Factor (F_{tb})
Data 7	Current Static Pressure	Data 16	Flowing Temperature Factor (F_{tf})
Data 8	Current Flowing Temperature	Data 17	Specific Gravity Factor (F_{gr})
Data 9	Mass Rate (per day)	Data 18	Compressibility Factor (F_{pv})

Gas=0,Steam=1,Liq=2: This field allows the user to select the measurement type. A value of “0” in this field indicates gas is being measured. A value of “1” in this field indicates steam/water is being measured. A value of “2” in this field indicates some type of fluid is being measured.

Calc (Vol=0,Mass=1): This field allows the user to select whether a volumetric flow rate calculation or mass flow rate calculation is performed. See section 2.1 for a detailed description of the calculations. A value of “0” in this field forces the program to perform the volumetric flow rate calculation. A value of “1” in this field forces the program to perform the mass flow rate calculation.

Sensor Model: This field allows the user to define the model and size of the Annubar sensor. Both Annubar Diamond II and Annubar 485 “T-shape” models are supported. For the Annubar 485 model, valid entries include “1”, “2”, and “3” defining the size of the 485 sensor. For the Annubar Diamond II model, valid entries include “10”, “15”, “16”, “25”, “26”, “35”, “36”, “45”, and “46” defining the sensor type. This selection will automatically define (set) the probe diameter (orifice diameter) in the normal meter setup configuration. Valid pipe diameters can be found in Appendix A for the Annubar models supported by the user program.

K (0=Calc,1=Enter): This field allows the user to select whether the Annubar flow coefficient (K) is calculated or entered. A “0” in this field forces the user program to calculate the coefficient based on sensor type and size and pipe diameter. A value of “1” in this field allows the user to enter the desired coefficient in the “Flow Coeff (K)” field. This option is necessary for Annubar models or types not supported by this user program. See Appendix A for list of supported models and types.

Flow Coeff (K): This field shows the Annubar Flow Coefficient (K) used in the rate calculation. This value may be calculated by the user program or entered by the user.

Enter Density (0=No): This field allows the user to select if density is supplied by a separate fluid properties user program or entered by the user. A “0” in this field indicates that a separate user program is installed to calculate and provide the density value. A value of “1” in this field allows the user to enter the desired flowing density in the “Flowing Density” field. This field can be ignored when performing a gas volume calculation.

Flowing Density: This field displays the density at flowing conditions. The density may be provided by a separate fluid properties user program or entered by the user. Density will be in lb_m/ft^3 if US units or kg/m^3 if metric units. This field can be ignored when performing a gas volume calculation.

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CalcFa=0,CorrDia=1: This field allows the user to select whether the flow calculation includes the thermal expansion factor, F_{aa} , or adjusts the pipe and Annubar probe diameters for temperature at flowing conditions. When the “CalcFa=0” option is selected, the values for pipe and probe diameters at temperature will equal the entered diameter values. The calculated thermal expansion factor accounts for the change in diameters at temperature. The entered coefficient values (A,B,C) are ignored. This field is available in version 1.01 and greater of the user program.

Therm Exp Fctr (Fa): This field shows the calculated thermal expansion factor applied to instantaneous flow calculation. This value will always equal 1.0 when the user has selected the correct diameters, “CorrDia=1”, option. This field is available in version 1.01 and greater of the user program.

Pipe Dia @ Temp: This field shows the corrected pipe diameter for temperature at flowing conditions. This value will equal entered pipe diameter when the calculate thermal expansion factor option, “CalcFa=0”, is selected. This value is calculated per AGA3 1992 standard for US units and GOST 8.563.1 standard for metric units. This field is available in version 1.01 and greater of the user program.

Probe Dia @ Temp: This field shows the corrected Annubar probe diameter for temperature at flowing conditions. This value will equal entered orifice diameter when the calculate thermal expansion factor option, “CalcFa=0”, is selected. This value is calculated per AGA3 1992 standard for US units and GOST 8.563.1 standard for metric units. This field is available in version 1.01 and greater of the user program.

Pipe Coeff A – Probe Coeff C: These fields allow the user to enter the A, B, C coefficients for required for the correction to orifice and pipe diameters per GOST standard 8.563.1. These fields are ignored unless the calculation is in metric units and the correct diameters for temperature, “CorrDia=1”, options are selected. These fields are available in version 1.01 and greater of the user program.

Properties Calc: This text field displays the gas or fluid properties calculation used to calculate and provide gas correction factors, density, and heating value. For gas volume calculations, this field may show “AGA8” if the FloBoss 103 internal AGA8 properties calculation is active. If a separate gas properties user program is active in the unit, the name of standards calculation implemented in that user program will be displayed. For mass calculations, a separate fluid properties user program must be active in the FloBoss 103 providing density and heating value. The text “None” will be displayed in this field when no valid fluid properties user program is active in the unit.

Diff Pressure: This field shows the live differential pressure reading in Inches H^2O if US units or kPa if metric units.

Static Pressure: This field shows the live static pressing reading in PSI if US units or kPa if metric units. This value may be an absolute or gauge pressure, depending on the configuration.

Flowing Temperature: This field shows the live flowing temperature reading in Degrees F if US units or Degrees C if metric units.

Mass Rate: This field shows the calculated mass flow rate in 1000 lb_m/day if US units or 1000 kilograms/day if metric units. This field will show zero when a volumetric calculation is being performed.

Volume Rate: This field shows the calculated volumetric flow rate in MCF/day if US units or km³/day if metric units. This field will show zero when a mass rate calculation is being performed.

Energy Rate: This field shows the calculated energy flow rate in MMBTU/day if US units or GJoules/day if metric units.

Mass Today: This field shows the accumulated mass in the current contract day, in 1000 lb_m if US units or 1000 kg if metric units.

Flow Today: This field shows the accumulated volumetric flow in the current contract day, in MCF if US units or km³ if metric units.

Energy Today: This field shows the accumulated energy in the current contract day, in MMBTU if US units or GJoules if metric units.

Mass Yesterday: This field shows mass accumulated the previous contract day, in 1000 lb_m if US units or 1000 kg if metric units.

Flow Yesterday: This field shows volumetric flow accumulated the previous contract day, in MCF if US units or km³ if metric units.

Energy Yesterday: This field shows energy accumulated the previous contract day, in MMBTU if US units or GJoules if metric units.

Calc Time (Seconds): This field shows the current rate calculation period. This value should always equal “1.0” during normal operation. A value greater than “1.0” may indicate the unit is overloaded.

❖ **NOTE:** If the user desires all the configuration to be restored and the user program to be turned on automatically after a Cold Start, then select the **Save Configuration** option on the **ROC > Flags** screen after configuring the Meter Setup and Annubar Flow Calc User Point.

5 MONITORING THE ANNUBAR FLOW PROGRAM

Operation and status of the Annubar flow calculation user program can be monitored from the Annubar flow calculation user defined point, softpoint parameters, and meter values display.

5.1 Annubar Flow Calc User Defined Point

Current input values, instantaneous rate values and accumulations today and yesterday can be viewed from the Annubar Flow Calc user defined point display. These values are updated once a second. See section 4.2 for a description of each value.

5.2 Annubar Softpoint Data

The user may enable the copy of Annubar data to a softpoint. The softpoint data contains current input values, instantaneous rate values, current density and gas correction factors. The softpoint data is updated once a second. See Section 4.2 for a description of each softpoint data parameter.

5.3 Meter Values Screen

The meter values screen is accessed through the **Meter > Values** selection on the ROCLINK 800 menu. The meter values screen is shown below. Current input values, instantaneous rate values, accumulation totals, and correction factors can be viewed on this screen. For gas applications, all units shown on the screen are correct. For mass applications, units shown as CF (or M³) are actually lb_m (kg) and units shown as MCF (or kM³) are actually 1000 lb_m (1000 kg).

Meter Values

Meter
 Run: [Dropdown] Tag: [Meter #1] DP: 7.012 kPa
 SP: 800.0 kPa
 Description: [Text] TP: 200.0 Deg C

Current Values

Flow Rate		Energy Rate	
142962.7	M3/hour	405981.2	MJ/hour
3431.104	kM3/day	9743.549	GJ/day

Accumulation

	kM3	GJ	Minutes
Today :	1994.647	5664.34	837.0
Yesterday :	1409.257	3991.458	588.2167
Month :	3403.586	9654.896	1425.217
Prev Month :	0.0	0.0	0.0
Accumulated :	3403.586	9654.896	1425.217

Factors

hwPf :	2.648018	Fpb :	1.002366
CdFT :	0.6	Ftb :	1.0
Ev :	1.000021	IMV :	53988.56
Y :	0.9989842	Fpwl :	1.0
Fpv :	1.0	Reynolds :	0.0

Upstream Static Pressure : 800.0 kPa
 Density : 3.833363 Kg/M3
 Orifice Diameter : 48.9141516 millimeters
 Pipe Diameter : 610.824534 millimeters
 Beta : 0.0800789

Buttons: [Auto Scan] [Update] [Cancel]

Figure 4. Meter Values Screen

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APPENDIX A - ANNUBAR PIPE ID & FLOW COEFFICIENT (K) REFERENCE TABLES

Linear interpolation may be used for pipe sizes not listed.

Type 10			
Nom Pipe Size, Inch	Schedule	Pipe ID	K
1/2	40	0.622	0.4265
3/4	40	0.824	0.5067
1	80	0.957	0.5547
	40	1.049	
1-1/4	80	1.278	0.587
	40	1.36	
1-1/2	80	1.5	0.603
	40	1.61	
2	80	1.939	0.6197
	40	2.067	

Type 15/16			
Nom Pipe Size, Inch	Schedule	Pipe ID	K
2	XX-STG	1.503	0.5627
	160	1.689	0.5746
	80	1.939	0.5865
	-	2	0.5888
2-1/2	40	2.067	0.5912
	XX-STG	1.771	0.5789
	160	2.125	0.5932
	80	2.323	0.599
3	40	2.469	0.6026
	-	2.5	0.6033
	XX-STG	2.3	0.5984
	160	2.624	0.6059
3-1/2	80	2.9	0.6109
	-	3	0.6124
	40	3.068	0.6134
	XX-STG	2.728	0.6079
4	80	3.364	0.6172
	-	3.5	0.6187
	40	3.548	0.6192
	XX-STG	3.152	0.6146
5	160	3.438	0.618
	80	3.826	0.6216
	-	4	0.6233
	40	4.026	0.6235
5	XX-STG	4.063	0.6237
	160	4.313	0.6255
	80	4.813	0.6285
	-	5	0.6295
	40	5.047	0.6297

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Type 25/26			
Nom Pipe Size, Inch	Schedule	Pipe ID	K
4	XX-STG	3.152	0.548
	80	3.826	0.5704
	-	4	0.5747
	40	4.026	0.5753
5	XX-STG	4.063	0.5762
	160	4.313	0.5814
	80	4.813	0.5901
	-	5	0.5928
6	40	5.087	0.5934
	XX-STG	4.987	0.5926
	160	5.189	0.5953
	80	5.761	0.6018
8	-	6	0.6014
	40	6.065	0.6047
	160	6.813	0.6105
	XX-STG	6.875	0.611
10	80	7.625	0.6155
	40	7.981	0.6173
	-	8	0.6174
	160	8.5	0.6196
12	80	9.564	0.6236
	X-STG	9.75	0.6242
	-	10	0.6249
	40	10.02	0.625
14	160	10.126	0.6253
	80	11.376	0.6285
	X-STG	11.75	0.6293
	40	11.938	0.6297
16	STD	12	0.6298
	80	12.5	0.6308
	X-STG	13	0.6317
	40	13.124	0.6319
18	STD	13.25	0.6319
	-	14	0.6332
	80	14.314	0.6337
	40	15	0.6346
20	STD	15.25	0.6349
	-	16	0.6357
	80	16.126	0.6359
	X-STG	17	0.6368
30	STD	17.25	0.637
	-	18	0.6377
	80	17.398	0.6371
	X-STG	19	0.6385
42	STD	19.25	0.6387
	-	20	0.6392

24	X-STG	23	0.641
	STD	23.25	0.6411
	-	24	0.6415
30	X-STG	29	0.6434
	STD	29.25	0.6435
	-	30	0.6437
36	X-STG	35	0.645
	STD	35.25	0.645
	-	36	0.6452
42	X-STG	41	0.6461
	STD	41.25	0.6461
	-	42	0.6462

Type 35/36			
Nom Pipe Size, Inch	Schedule	Pipe ID	K
12	160	10.126	0.6116
	80	11.376	0.6165
	X-STG	11.75	0.6178
	40	11.938	0.6184
14	STD	12	0.6186
	80	12.5	0.62
	X-STG	13	0.6214
	40	13.124	0.6217
16	STD	13.25	0.622
	-	14	0.6238
	80	14.314	0.6245
	40	15	0.6259
18	STD	15.25	0.6263
	-	16	0.6276
	80	16.126	0.6278
	X-STG	17	0.6292
20	STD	17.25	0.6296
	-	18	0.6306
	80	17.938	0.6305
	X-STG	19	0.6318
24	STD	19.25	0.6321
	-	20	0.6329
	80	21.564	0.6344
	S-STG	23	0.6355
30	STD	23.25	0.6357
	-	24	0.6363
	X-STG	29	0.6392
	STD	29.2503	0.6393
36	-	30	0.6396
	X-STG	35	0.6415
	STD	36.25	0.6416
	-	36	0.6418
42	X-STG	41	0.6431
	STD	41.25	0.6432
	-	42	0.6434

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Type 35/36			
Nom Pipe Size, Inch	Schedule	Pipe ID	K
48	-	48	0.6445
60	-	60	0.6461
72	-	72	0.6472
84	-	84	0.6479
96	-	96	0.6485

Type 45/46			
Nom Pipe Size, Inch	Schedule	Pipe ID	K
24	80	21.564	0.6224
	X-STG	23	0.6244
	STD	23.25	0.6248
	-	24	0.6257
30	X-STG	29	0.6306
	STD	29.25	0.6308
	-	30	0.6314
36	X-STG	35	0.6345
	STD	35.25	0.6347
	-	36	0.635
42	X-STG	41	0.6373
	STD	41.25	0.6374
	-	42	0.6376
48	-	48	0.6395
60	-	60	0.6422
72	-	72	0.6439
84	-	84	0.6452
96	-	96	0.6461

Annubar Diamond II Probe Diameter Reference Table - Use actual pipe diameter if not listed above and probe diameters in table below.

Type	Diameter (inches)
10	0.173
15/16	0.365
25/26	0.856
35/36	1.235
45/46	1.950

Annubar 485 Probe Diameter Reference Table - Use actual pipe diameter and probe diameters in table below.

Size	Diameter (inches)
1	0.590
2	1.060
3	1.920

If you have comments or questions regarding this manual, please direct them to your local sales representative or contact:

**Emerson Process Management
Flow Computer Division**

Marshalltown, IA 50158 U.S.A

Houston, TX 77065 U.S.A.

Pickering, North Yorkshire UK Y018 7JA

Website: www.EmersonProcess.com/flow