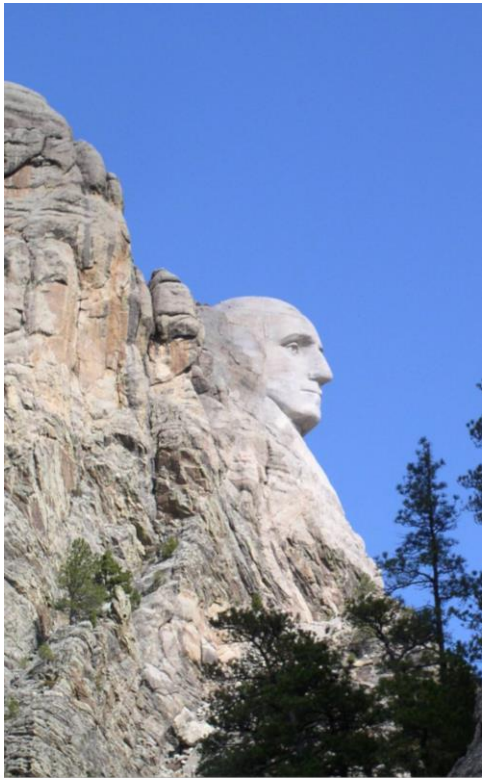

Bob Bennett
June 2020

Meter Sizing and Selection

2020 Northeast Gas Association Gas Operations School

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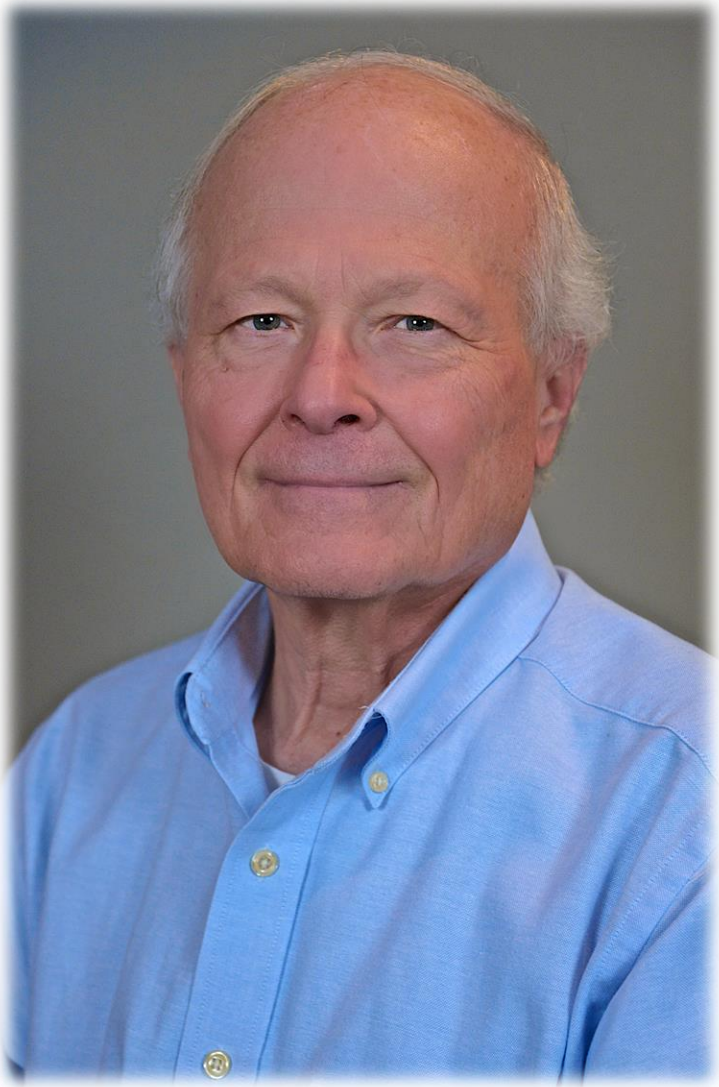
Welcome

Bob Bennett
Honeywell
Nebraska City, NE
30 Years
Southwest Gas Corporation
West Ohio Gas Company
Robert.bennett@Honeywell.com



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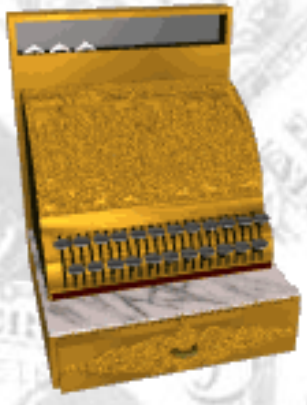
Gas Measurement Law

$$\text{Billing in Volume } (V_B) = V_{Meter} \text{ x } \left(\frac{P_M}{P_B}\right) \text{x } \left(\frac{T_B}{T_M}\right) \text{x } (F_{PV})^2$$

$$\text{Billing in Energy} = V_{Meter} \text{ x } \left(\frac{P_M}{P_B}\right) \text{x } \left(\frac{T_B}{T_M}\right) \text{x } (F_{PV})^2 \text{x } \left(\frac{BTU}{FT^3}\right) \text{x } \left(\frac{\text{Therm}}{100{,}000\ BTU}\right)$$

V_{Meter}	=	Metered Volume (Uncorrected)
P_M	=	Absolute Metering Pressure
P_B	=	Base Pressure
T_B	=	Absolute Base Temperature
T_m	=	Absolute Metering Temperature
F_{pv}	=	Supercompressibility Factor



Measurement Components

- *Tariffs and Codes*
- *Metering*
- *Regulation*
- *Instrumentation*

"If at first you don't succeed, cheat."

Red Buttons

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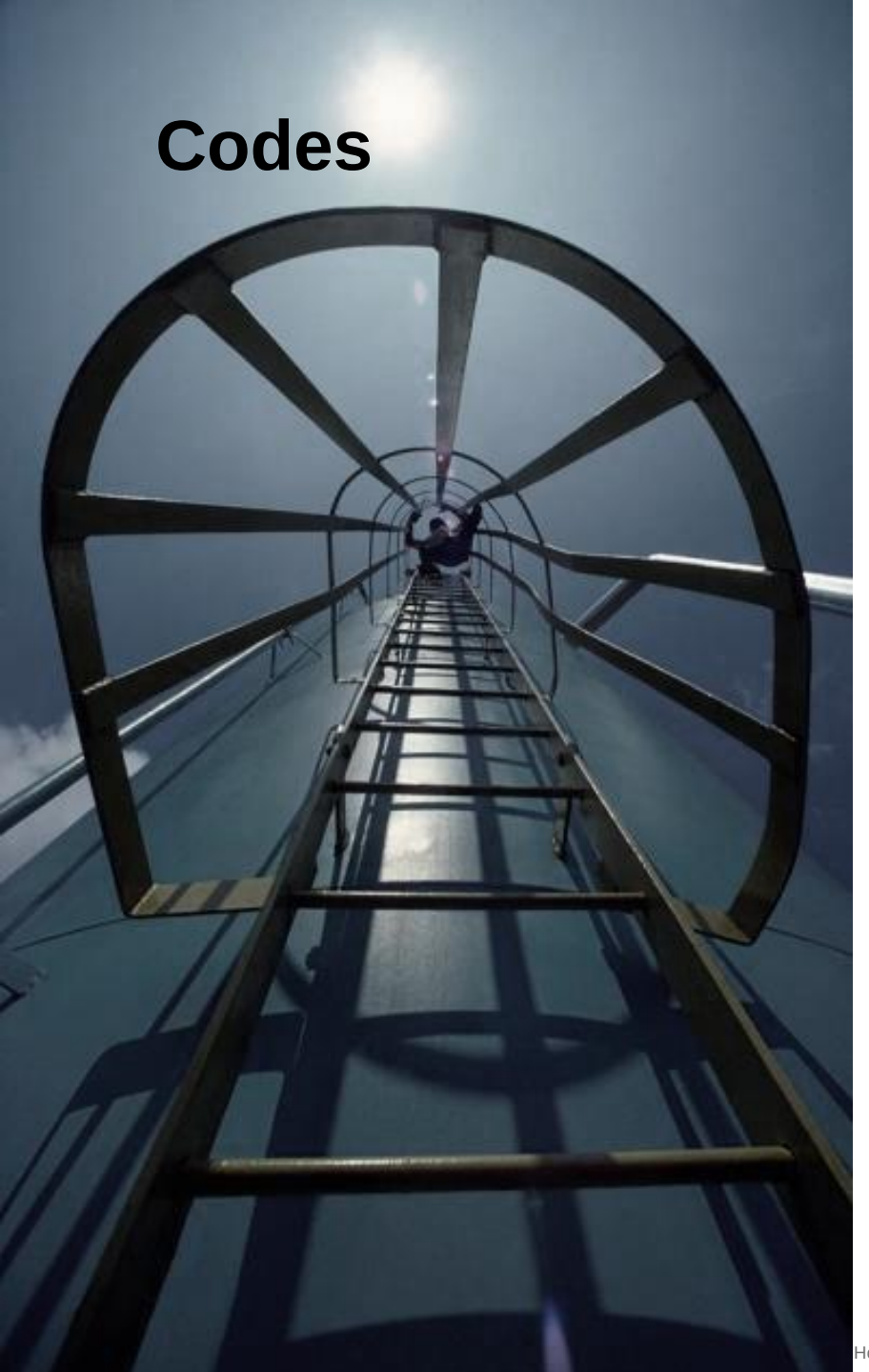

Codes

- Department of Transportation
- State Utility Commission Rules and Regulations
- National Fuel Gas Code
- Manufacturers Specifications and Recommendations
- Company Standards and Procedures
- AGA and/or ANSI Standards
- National Electrical Code
- API 1104 Welding

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Tariffs – Billing in Volume

$$V_{Base} = V_{Meter}\ x\ \frac{P_M}{P_B}\ x\ \frac{T_B}{T_M}\ x\ {F_{pv}}^2$$

Tariff (Rate Structure) defines:

- Units for Billing (Cubic Feet or Therms)
- Base Pressure (P_b)
- Base Temperature (T_b)
- Range of Heating Value
- Nature and Allowable Cost of Service
- Operating Practices

Tariffs – Billing in Energy

$$Billing\ in\ Energy = V_{Meter}\ x\ \left(\frac{P_M}{P_B}\right) x\ \left(\frac{T_B}{T_M}\right) x\ (F_{PV})^2 x\ \left(\frac{BTU}{FT^3}\right) x\ \left(\frac{Therm}{100{,}000\ BTU}\right)$$

Where E = Therms

Measurement Components

- *Tariffs and Codes*
- *Metering*
- *Regulation*
- *Instrumentation*

"Ideas are a dime a dozen. People who put them into action are priceless."

Unknown

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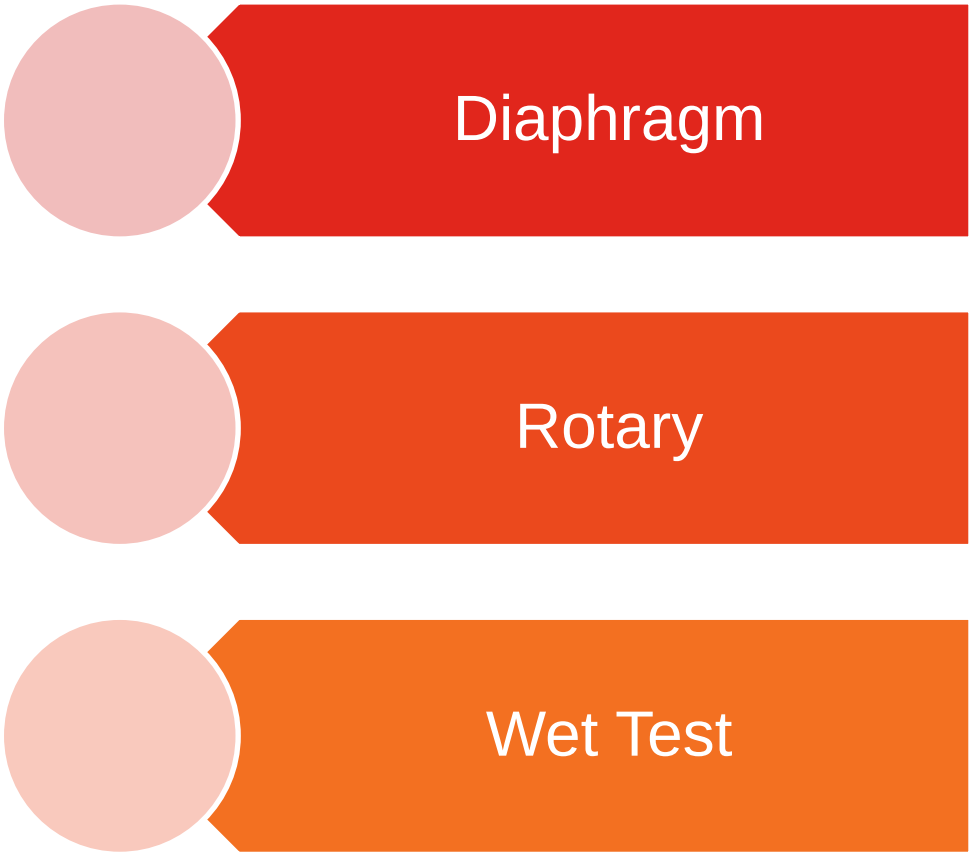
Metering

Gas Measurement Law

$$V_{Base} = V_{Meter}\ x\ \frac{P_M}{P_B}\ x\ \frac{T_B}{T_M}\ x\ {F_{pv}}^2$$

Various types of meters provide the V_{Meter}, the Uncorrected Volume or the Volume registered by the meter.

Types of Meters – Positive Displacement



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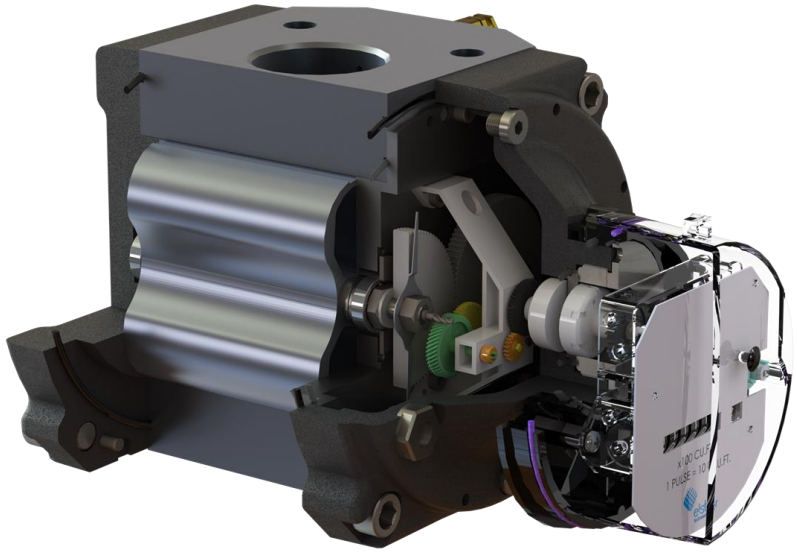
Positive Displacement

1. Diaphragm

Positive Displacement

1. Diaphragm
2. Rotary



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Positive Displacement

1. Diaphragm
2. Rotary
3. Wet Test

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Types of Meters – Inferential

- Turbine
- Orifice
- Elbow & Centrifugal
- Differential Head Meters
- Area Meters
- Sonic/Ultrasonic Meters
- Mass Meters

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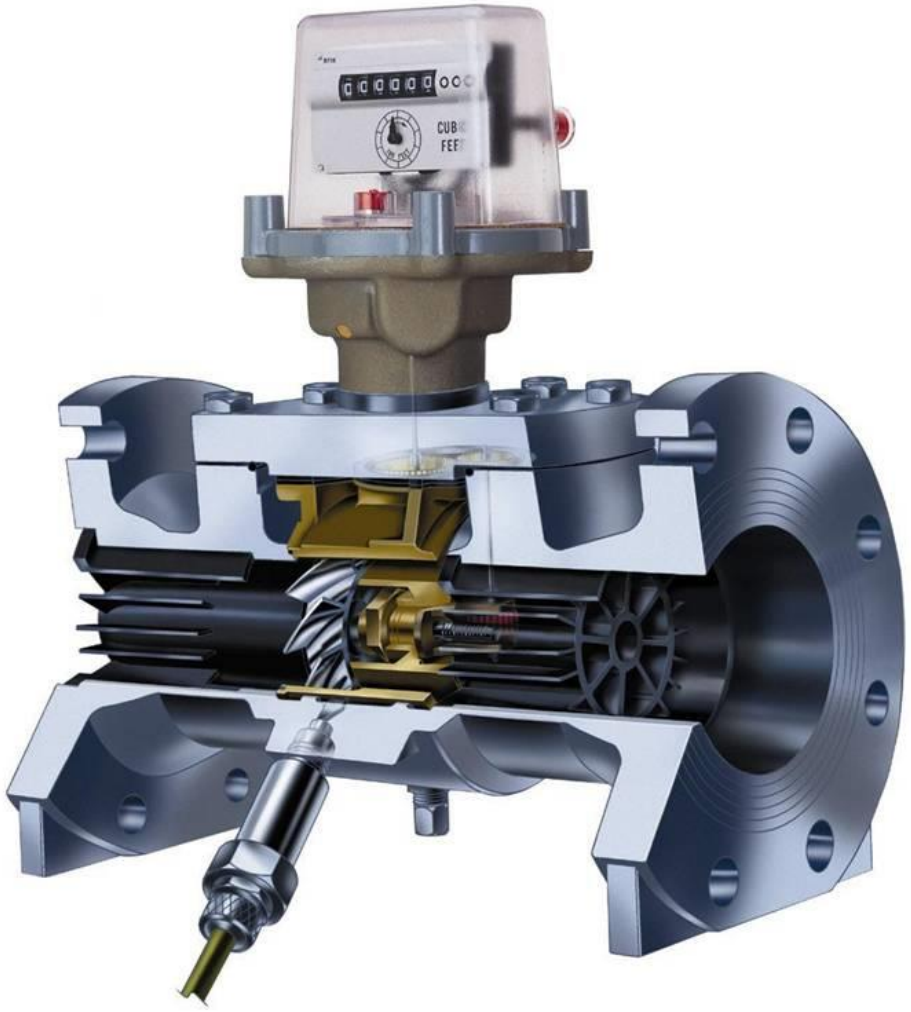
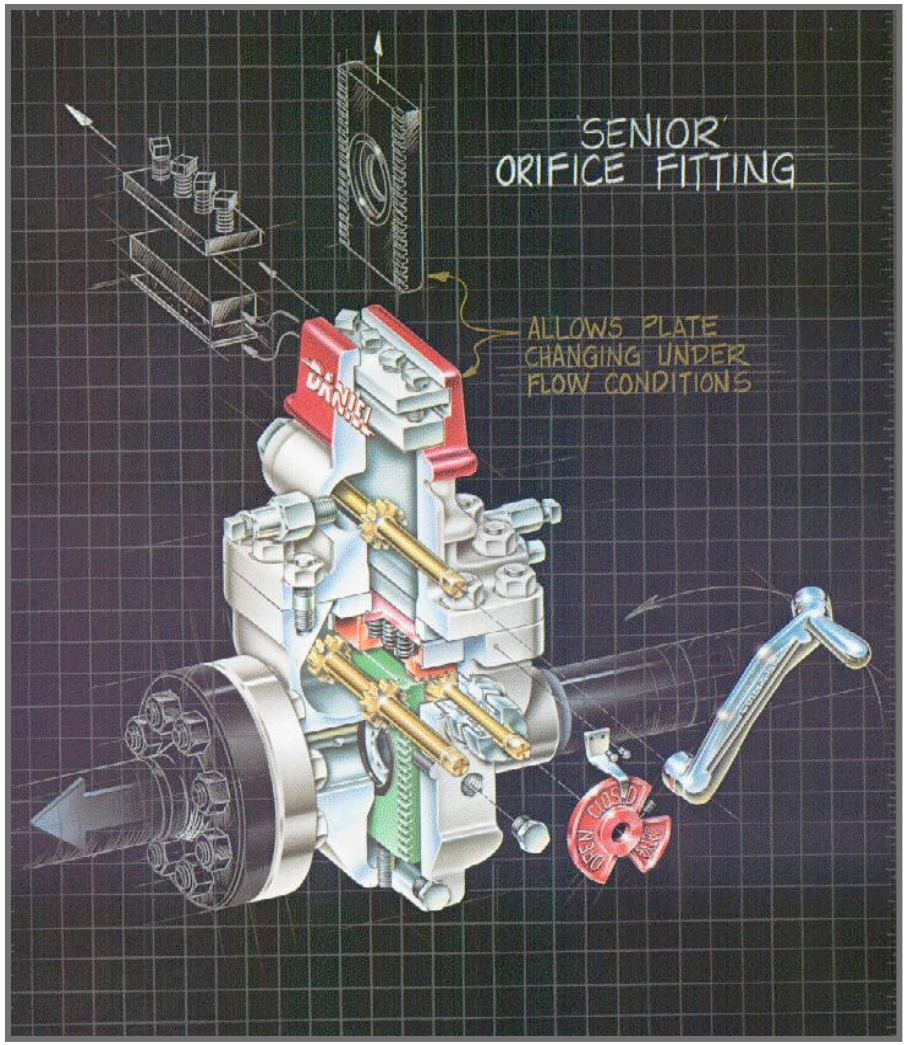
Inferential Meters

1. Turbine



Inferential Meters

1. Turbine
2. Orifice



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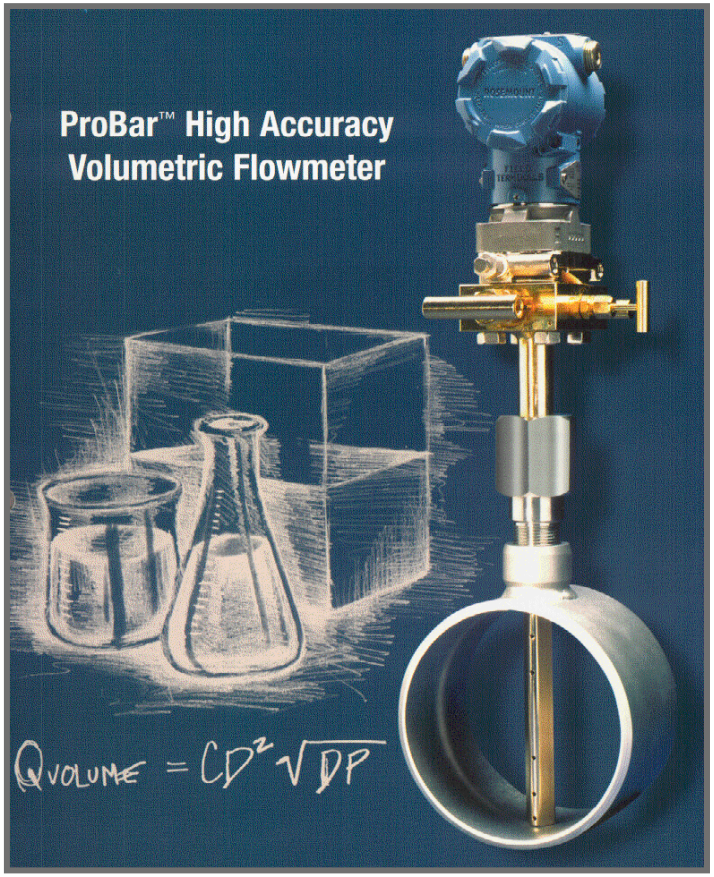
Inferential Meters

1. Turbine
2. Orifice
3. Differential Head



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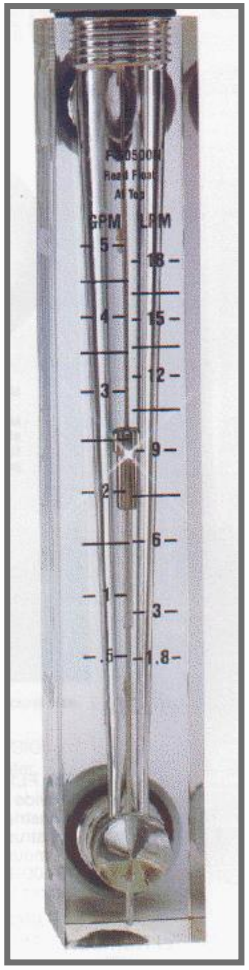
Inferential Meters

1. Turbine
2. Orifice
3. Differential Head
4. Area Meter



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Inferential Meters

1. Turbine
2. Orifice
3. Differential Head
4. Area Meter
5. Ultrasonic

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Inferential Meters

1. Turbine
2. Orifice
3. Differential Head
4. Area Meter
5. Ultrasonic
6. Mass Meter

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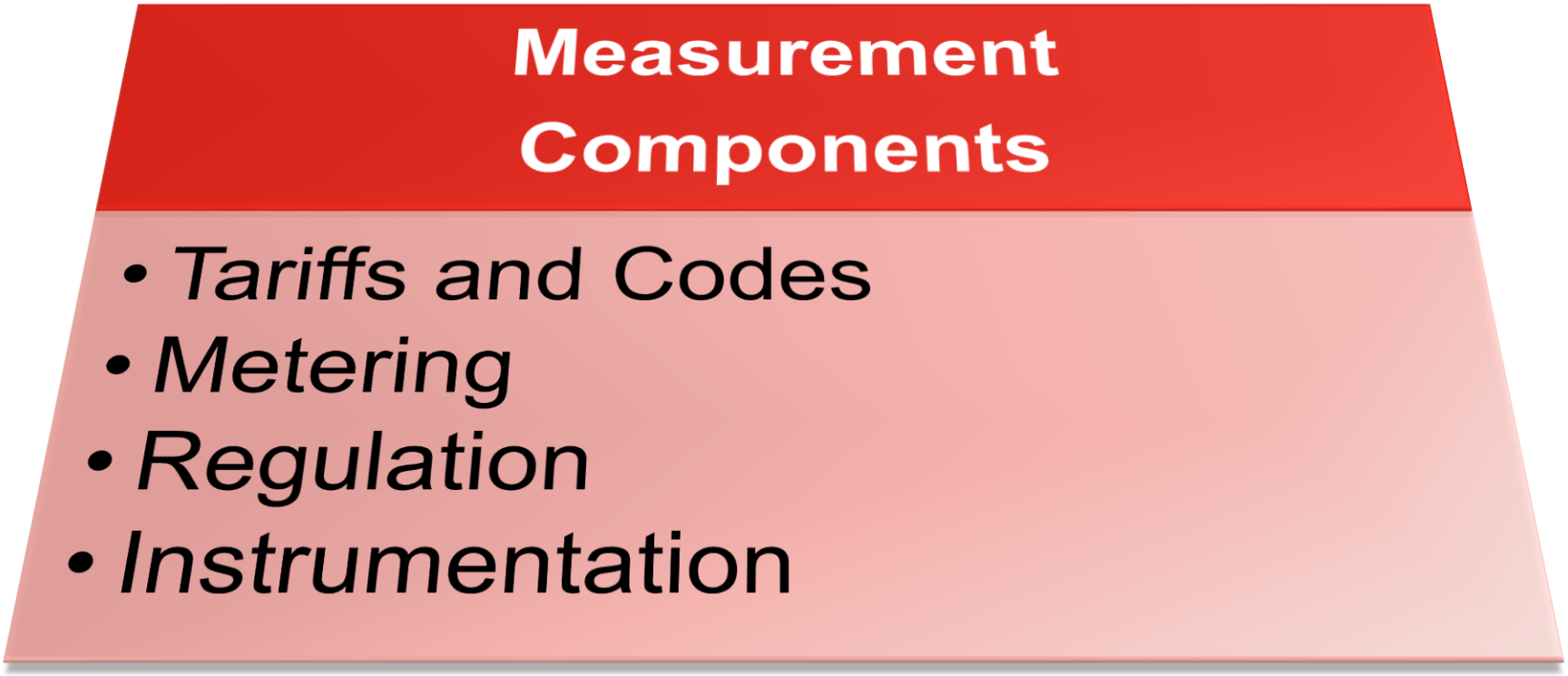

"Some of those in the rear may not be able to hear me. Those of you in the front may want to go back and join them."

Unknown

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Regulation

Gas Measurement Law

$$V_{Base} = V_{Meter}\ x\ \frac{P_M}{P_B}\ x\ \frac{T_B}{T_M}\ x\ {F_{pv}}^2$$

Regulation provides the P_M, the pressure on the gas flowing through the meter.

Regulation

Low Pressure Meter Sets

Fixed Factor Meter Sets

Line Pressure Meter Sets

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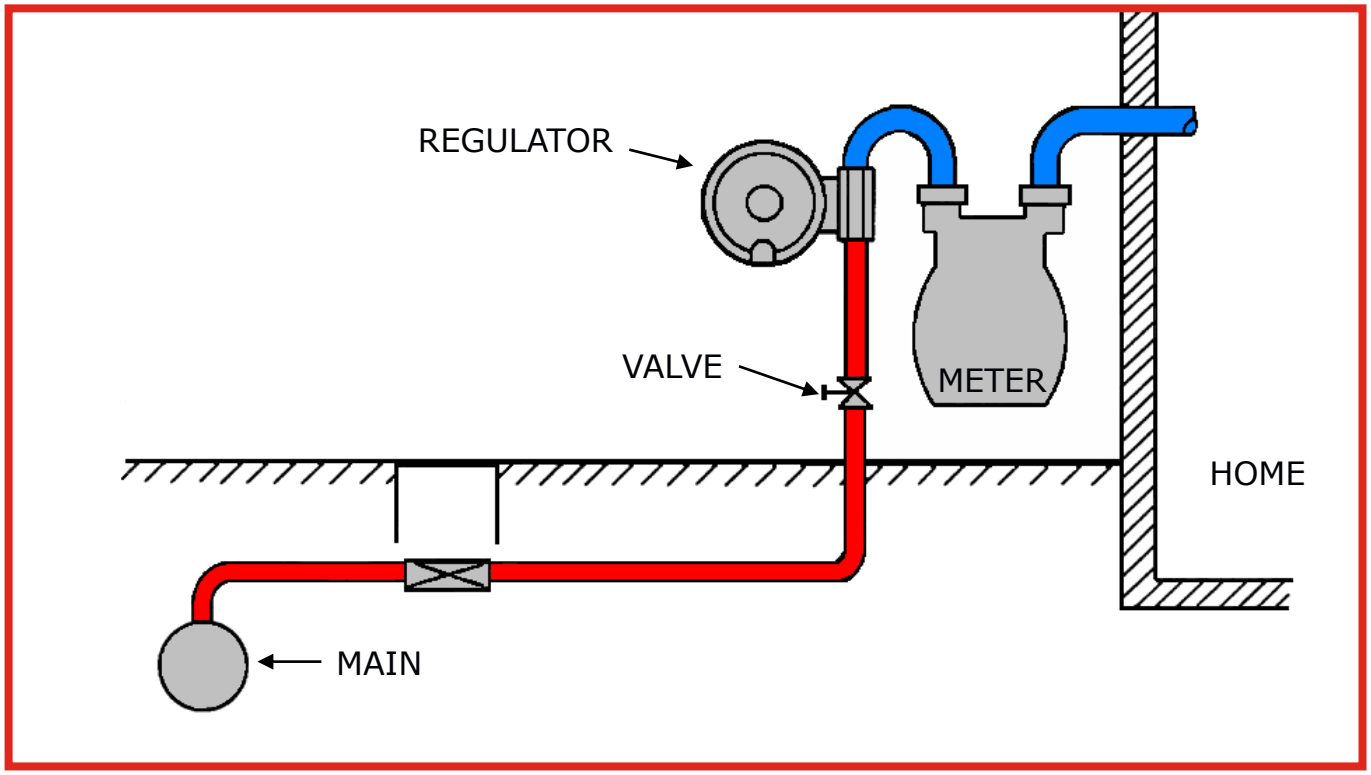
Low Pressure Meter Sets

Meter measures gas at or near to base conditions (7” w.c.)



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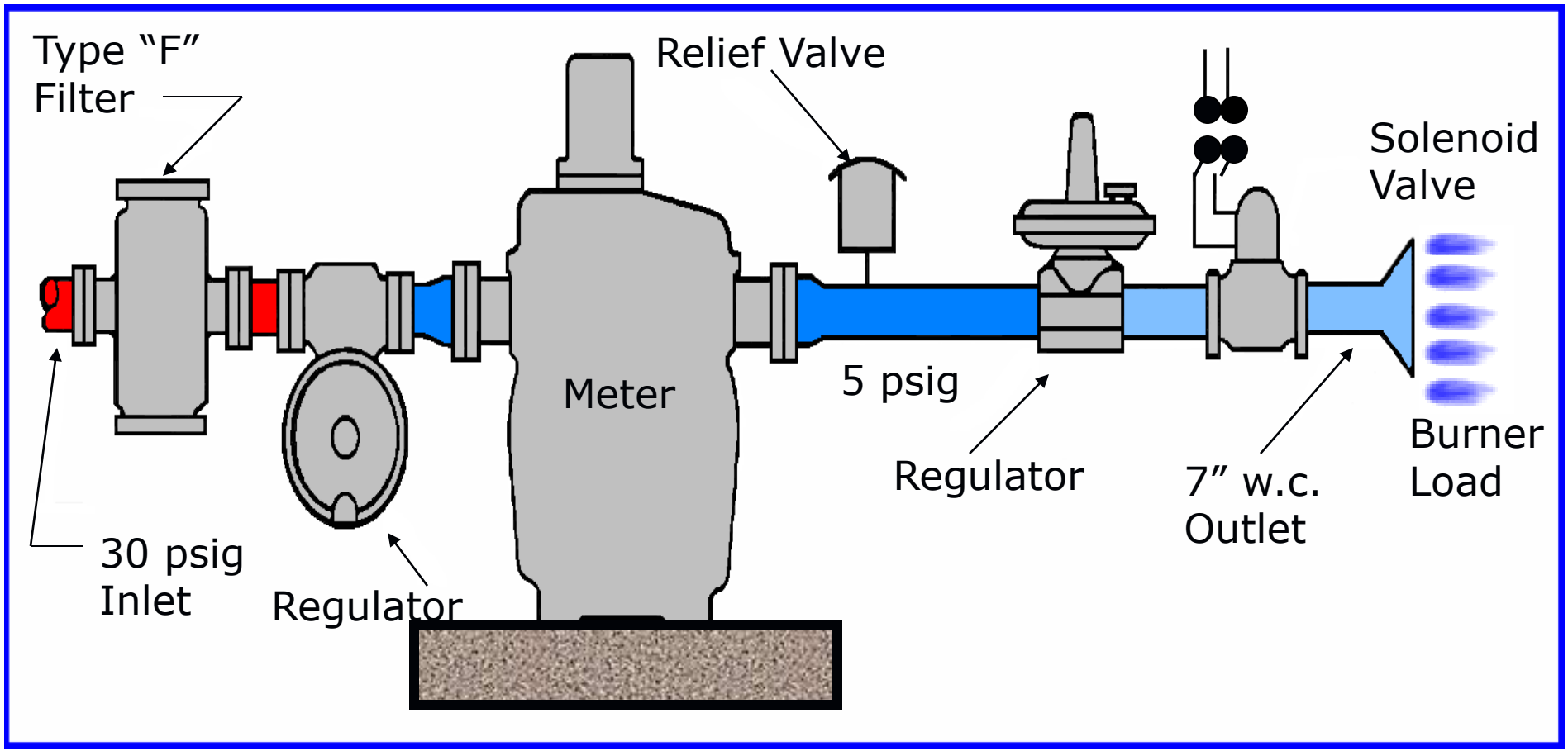
Fixed Factor Meter Sets



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7516
10 P.S.I.

Fixed Factor Meter Sets

Fixed Factor Meter Sets demand a constant delivery pressure through a positive displacement or turbine meter.

$$V_{Base} = V_{Meter}\ x\ \frac{P_M}{P_B}\ x\ \frac{T_B}{T_M}\ x\ {F_{pv}}^2$$

The metered volume (V_{Meter}) is multiplied by a “Fixed Pressure” Correction Factor.

Fixed Factor Meter Sets

Pressure Correction Factor = P_m / P_b

Where:

P_m = Flowing Pressure + Atmospheric Pressure

P_b = Base Pressure

The prime requisite is accurate regulation over a range of flow rates going through the meter

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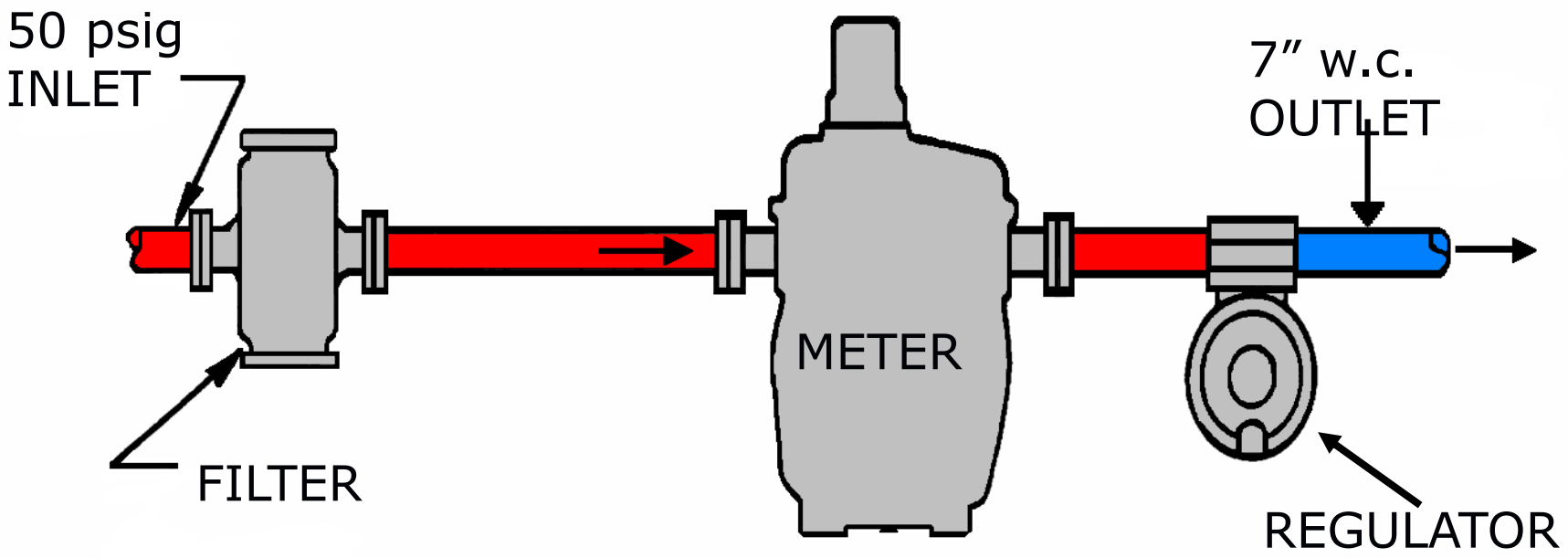
Line Pressure Meter Sets



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Line Pressure Meter Sets

Line Pressure Meter Sets have constantly changing pressures and/or temperatures flowing through the meter.

Line Pressure Meter Sets

The metered volume therefore must be multiplied by variable Pressure, Temperature and Supercompressibility Factors.

$$V_{Base} = V_{Meter}\ x\ \frac{P_M}{P_B}\ x\ \frac{T_B}{T_M}\ x\ {F_{pv}}^2$$

Measurement Components

- *Tariffs and Codes*
- *Metering*
- *Regulation*
- *Instrumentation*

"Thanks to the Interstate System, it is now possible to go coast to coast without seeing anything."

Charles Kuralt

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Instrumentation

Gas Measurement Law

$$V_{Base} = V_{Meter}\ x\ \frac{P_M}{P_B}\ x\ \frac{T_B}{T_M}\ x\ {F_{pv}}^2$$

Instrumentation can provide P_m , T_m and F_{pv}

The gas components and/or characteristics to determine F_{pv}^2

Volumes based on various Basic Gas Laws

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Correctors

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Electronic Indexes

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Chromatographs

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Communications

- MODBUS - programmable
  - 1x TCP/IP
  - 2x RS485 interface
- 4 digital outputs
- 2 digital inputs
- 4 analog outputs
- Integrated logging
  - Measurements as mean values (e.g. on hourly basis) or current values. Integrated logging of measurement system status and external events

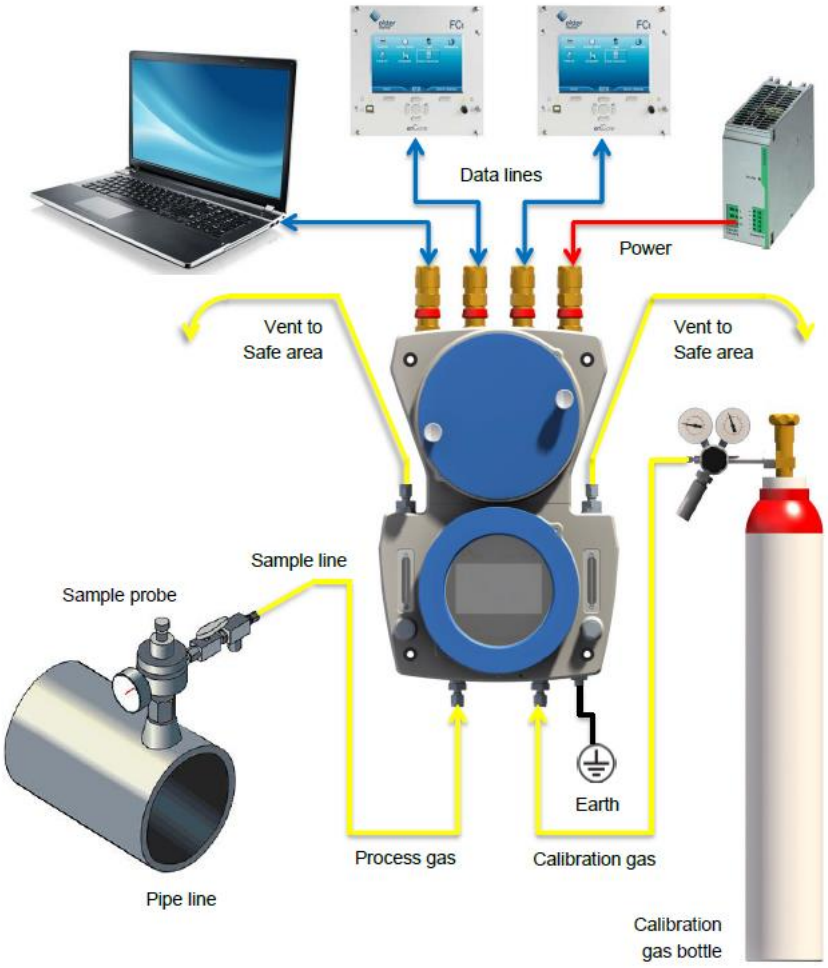

Figure 3.4: General system setup

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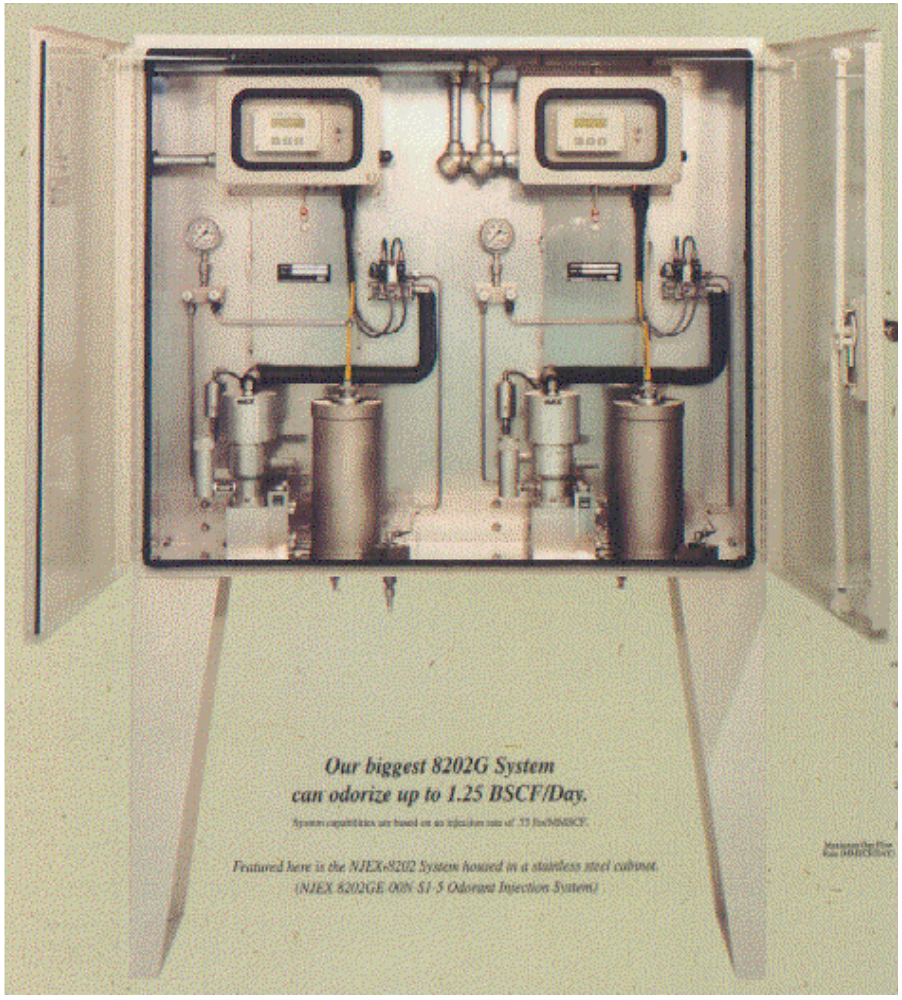
Odorization



Moisture Analyzers

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Automatic Meter Reading

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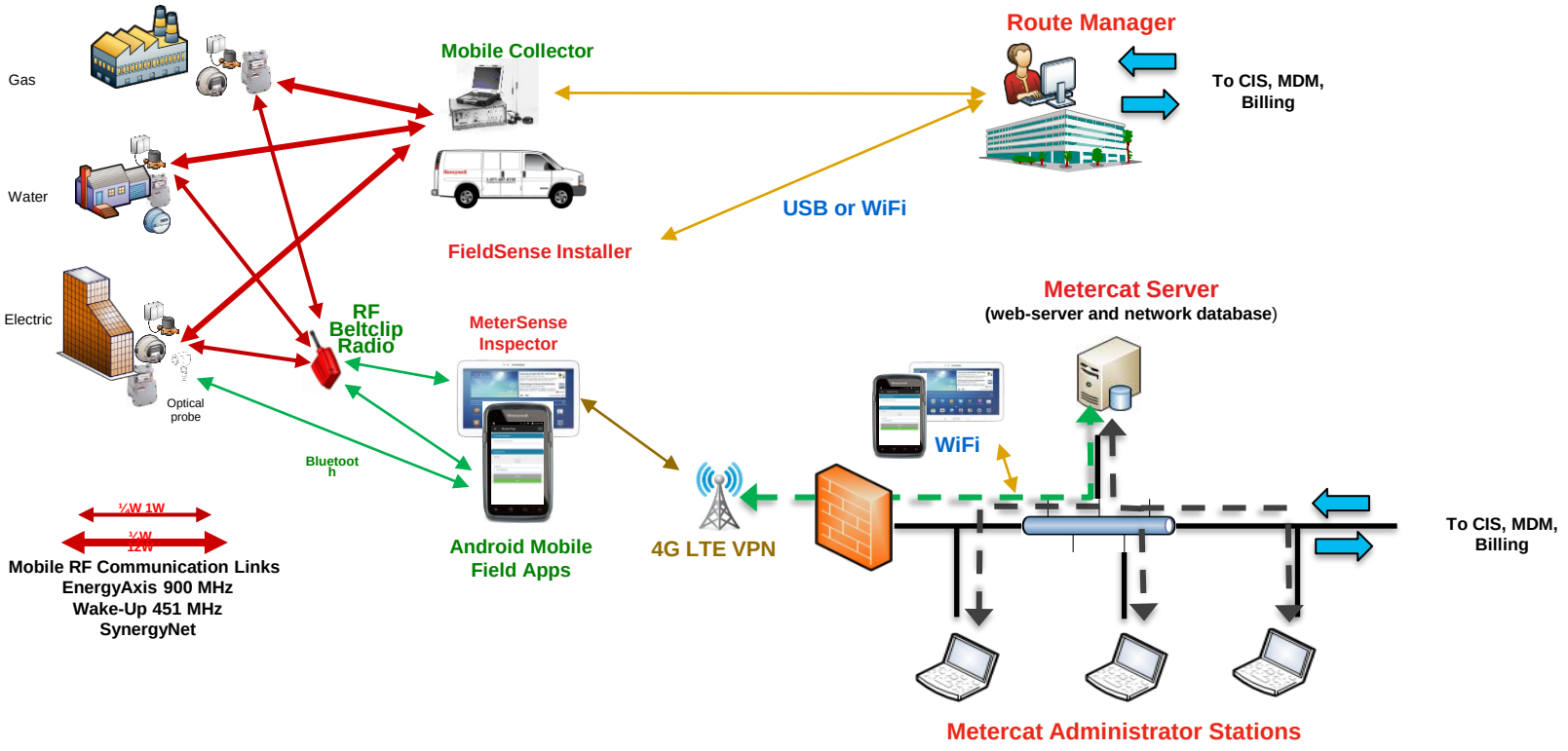
Automatic Meter Reading



Wireless Telemetry

Applications:

- Gas system pressure monitoring
- Distribution Metering
- Gas Pipeline Metering
- Gas Wellhead Metering
- Corrosion Monitoring
- Renewable power assemblies
- Serial Transparent Cellular Modem assemblies (3rd party equipment)

Technologies

- Cellular – GSM/GPRS/HSPA, CDMA
- ISM Radio (licensed & unlicensed; incl. 902 MHz)
- LEO Satellite
- GEO Satellite
- Power Technologies: Solar; Class 1 Division 2 AC Power; Thermal Electric Generator; advanced battery systems

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MSA Considerations

Type of Customer

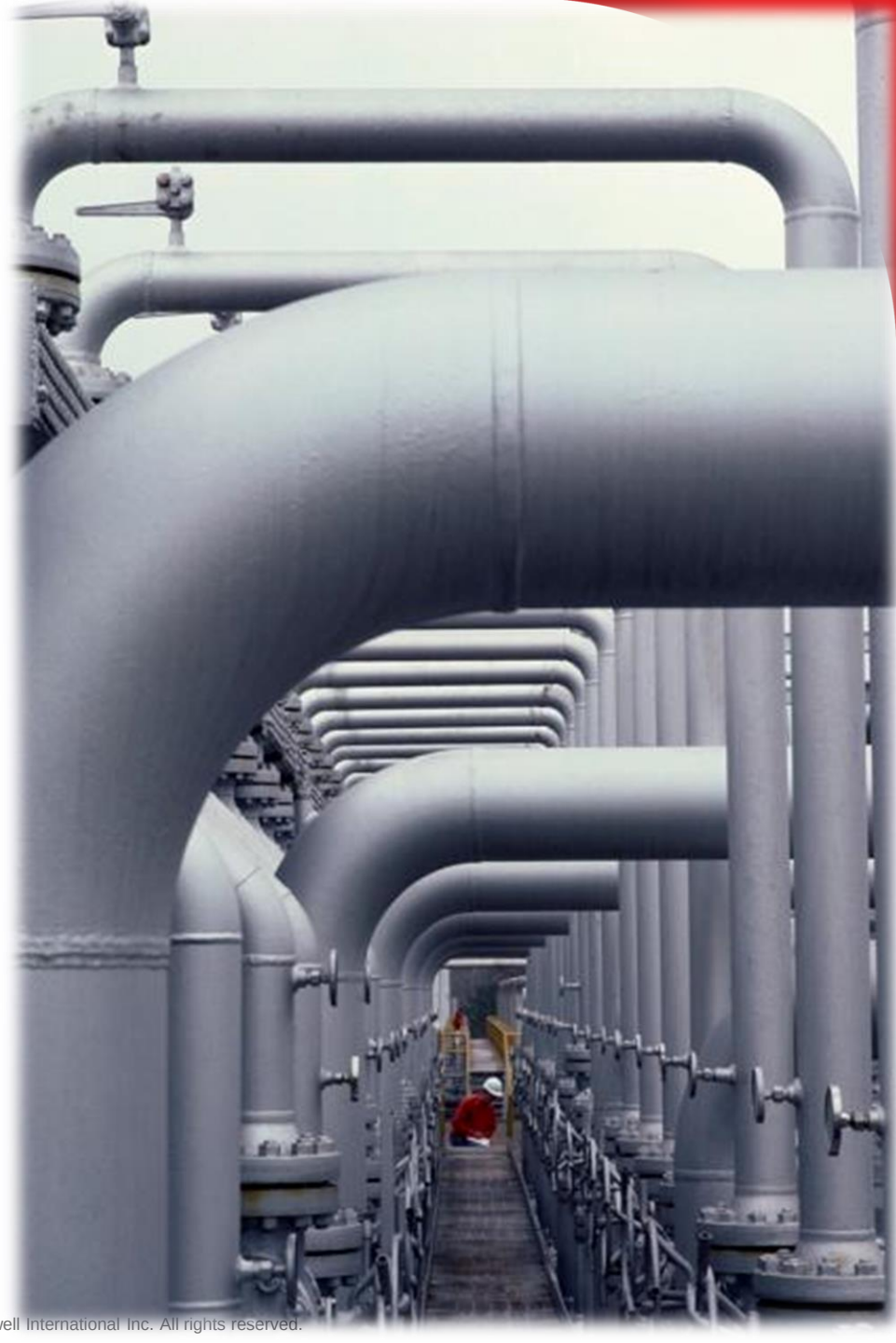
Connected Load

Diversity Factor

Pressure Needed

MSA Considerations

Initial Cost
Future Maintenance Costs
Overall Accuracy
Location, Access
Long Term Performance
Rate of Return on Investment



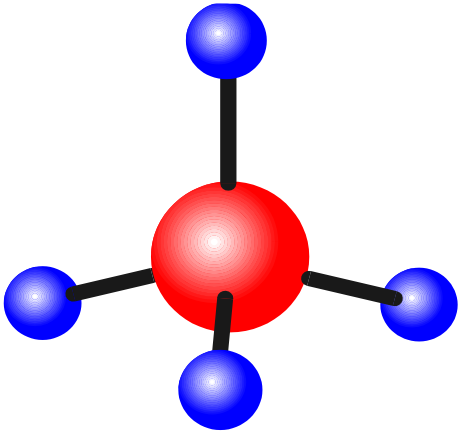
Sizing Exercise

Type of Load	*BTU Rating*	*FT^3/Hour*
Water Heater	40,000	
Furnace	100,000	
Dryer	20,000	
Range	40,000	
Total	200,000	
Pool Heater		
BBQ		
Spa		
Total	200,000	

Sizing Exercise

One Cubic Foot of Natural Gas = Approximately 1000 BTUs of Heating Value

One Therm = Approximately 100 ft^3 of Natural Gas



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Sizing Exercise

Type of Load	*BTU Rating*	*Ft^3/Hour*
Water Heater	40,000	40
Furnace	100,000	100
Dryer	20,000	20
Range	40,000	40
Total	200,000	200
Pool Heater		
BBQ		
Spa		
Total	200,000	200

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Diaphragm Meter Capacity Table

Meter Capacities

Diaphragm Meter Capacities * scfh (Sm^3/h)									
Line Pressure	AT-210	AT-250 AC-250 AM-250 AR-250	AL-425	AC-630	AL-800	AL-1000	AL-1400	AL-2300	AL-5000
0.25 psig (17 mBarg)	210 (5.9)	250 (7.1)	425 (12.0)	630 (17.8)	800 (22.7)	1000 (28.3)	1400 (39.6)	2300 (65.1)	5000 (141.6)
2 psig (14 mBarg)	424 (12.0)	550 (15.6)	955 (27.0)	1390 (39.4)	1850 (52.4)	2400 (68.0)	3265 (92.5)	5440 (154.0)	12000 (339.8)
5 psig (345 mBarg)	462 (13.1)	593 (16.8)	1100 (31.1)	1515 (42.9)	2100 (59.5)	2700 (76.5)	3700 (104.8)	6200 (175.6)	13500 (382.3)
10 psig (690 mBarg)	–	–	1350 (38.2)	1710 (48.4)	2600 (73.6)	3400 (96.3)	4600 (130.3)	7700 (218.1)	1700 (481.4)
20 psig (1.4 Barg)	–	–	1700 (48.1)	2010 (56.9)	3200 (90.6)	4100 (116.1)	5600 (158.6)	9400 (266.2)	20600 (583.4)
25 psig (1.7 Barg)	–	–	1880 (53.2)	2160 (61.2)	3500 (99.1)	4600 (130.3)	6200 (175.6)	10400 (294.5)	23000 (654.4)
50 psig (3.4 Barg)	–	–	–	–	5100 (144.4)	6600 (186.9)	9000 (254.9)	15000 (424.8)	33000 (934.6)
75 psig (5.2 Barg)	–	–	–	–	6600 (186.9)	8540 (241.8)	11650 (329.9)	19400 (549.4)	42700 (1209.1)
100 psig (6.9 Barg)	–	–	–	–	7800 (220.9)	10100 (286.0)	13800 (390.8)	23000 (651.4)	50500 (1,430.2)

* Capacity data based upon natural gas with specific gravity of 0.60.

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Sizing Exercise

Type of Load	*BTU Rating*	*Ft^3/Hour*
10 - 250,000 BTU Furnaces		
5 - 50,000 BTU Heaters		
1 - 2,500,000 BTU Boilers		
Total		

Sizing Exercise

Type of Load	*BTU Rating*	*Ft^3/Hour*
10 - 250,000 BTU Furnaces	2,500,000	2,500
5 - 50,000 BTU Heaters	250,000	250
1 - 2,500,000 BTU Boilers	2,500,000	2,500
Total	5,250,000	5,250

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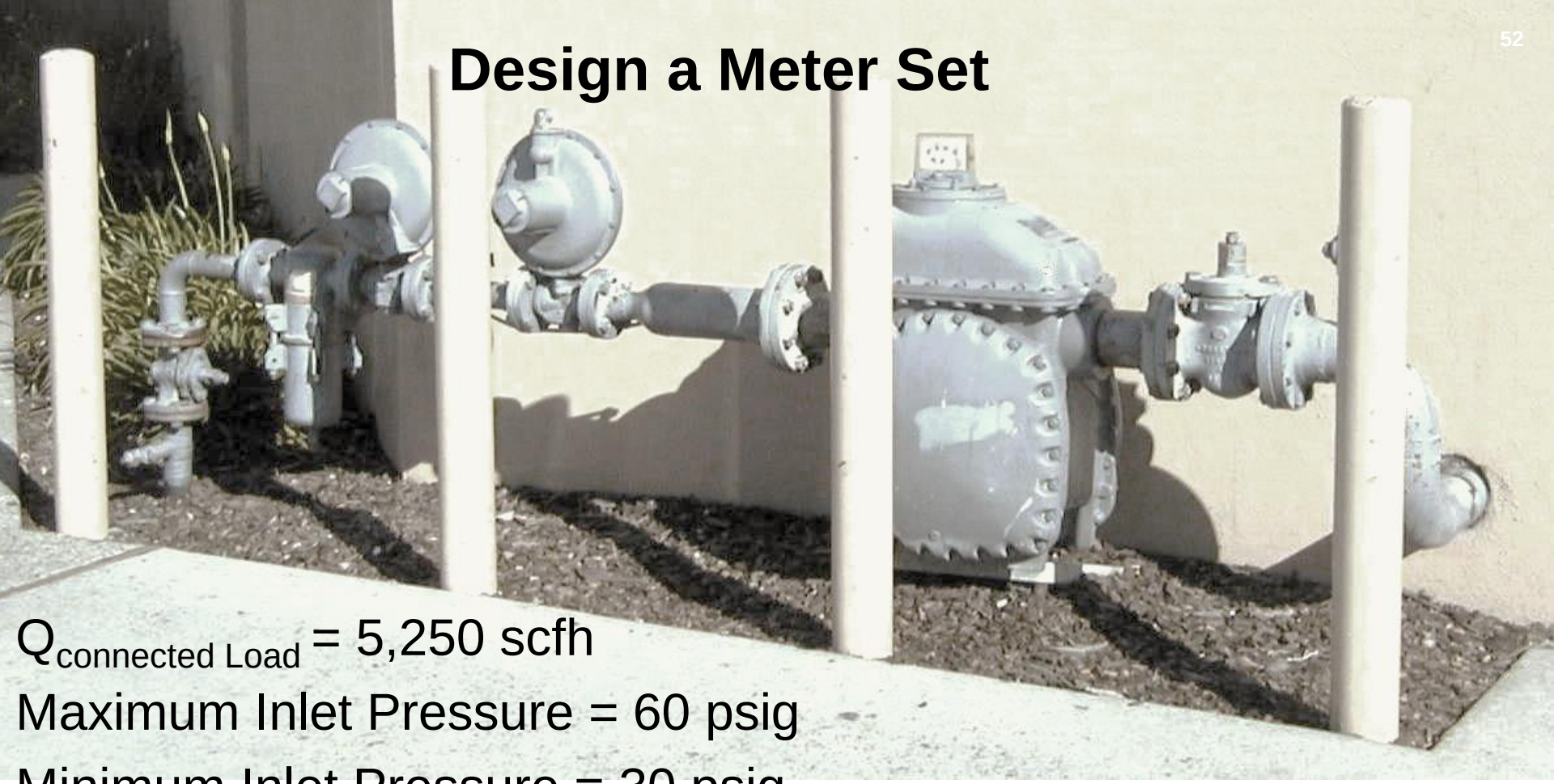
Design a Meter Set



$Q_{connected\ Load}$ = 5,250 scfh

Maximum Inlet Pressure = 60 psig

Minimum Inlet Pressure = 30 psig

Outlet Pressure = 5 PSIG

Customer needs 7” w.c. @ Burners

No Diversity Factor

$Q_{minimum}$ = 10 scfh

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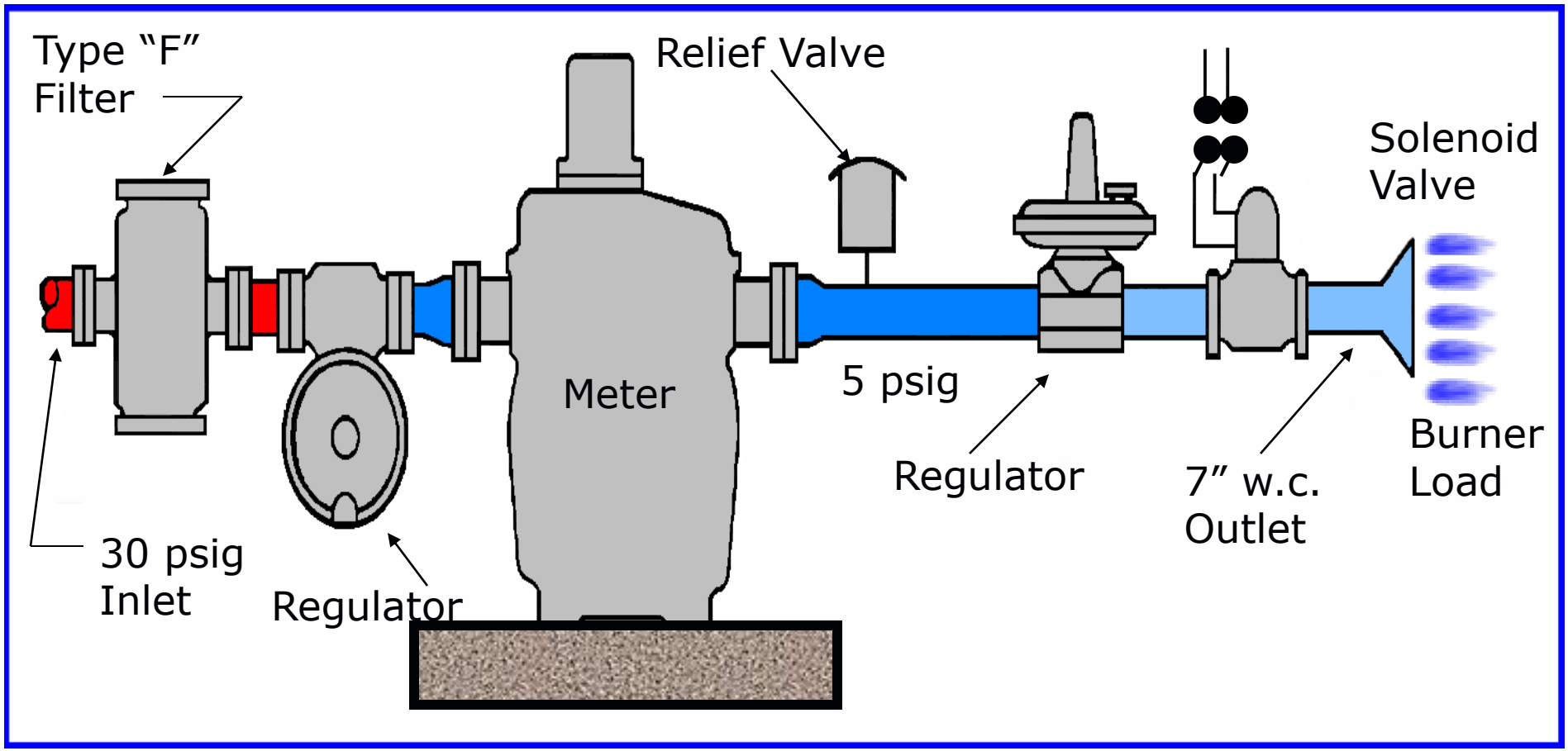
Fixed Factor Meter Sets



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Diaphragm Meter Capacity Table

Meter Capacities

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2 psig (14 mBarg)	424 (12.0)	550 (15.6)	955 (27.0)	1390 (39.4)	1850 (52.4)	2400 (68.0)	3265 (92.5)	5440 (154.0)	12000 (339.8)
5 psig (345 mBarg)	462 (13.1)	593 (16.8)	1100 (31.1)	1515 (42.9)	2100 (59.5)	2700 (76.5)	3700 (104.8)	6200 (175.6)	13500 (382.3)
10 psig (690 mBarg)	–	–	1350 (38.2)	1710 (48.4)	2600 (73.6)	3400 (96.3)	4600 (130.3)	7700 (218.1)	1700 (481.4)
20 psig (1.4 Barg)	–	–	1700 (48.1)	2010 (56.9)	3200 (90.6)	4100 (116.1)	5600 (158.6)	9400 (266.2)	20600 (583.4)
25 psig (1.7 Barg)	–	–	1880 (53.2)	2160 (61.2)	3500 (99.1)	4600 (130.3)	6200 (175.6)	10400 (294.5)	23000 (654.4)
50 psig (3.4 Barg)	–	–	–	–	5100 (144.4)	6600 (186.9)	9000 (254.9)	15000 (424.8)	33000 (934.6)
75 psig (5.2 Barg)	–	–	–	–	6600 (186.9)	8540 (241.8)	11650 (329.9)	19400 (549.4)	42700 (1209.1)
100 psig (6.9 Barg)	–	–	–	–	7800 (220.9)	10100 (286.0)	13800 (390.8)	23000 (651.4)	50500 (1,430.2)

* Capacity data based upon natural gas with specific gravity of 0.60.

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Rotary Meter Capacity Table

SIZING CHART											
Model		3.5M/G65		5.5M/G100		9M/G160		14M/G250		23M/G400	
psig	[Barg]	Corrected Capacity in scfh [sm^3/h]									
0.25	[0.0]	3,500	[100]	5,500	[160]	9,000	[250]	14,000	[400]	23,000	[650]
2	[0.1]	3,900	[110]	6,100	[170]	10,000	[280]	15,600	[440]	25,300	[715]
5	[0.3]	4,600	[130]	7,200	[200]	11,900	[340]	18,400	[520]	30,400	[850]
10	[0.7]	5,800	[160]	9,100	[260]	14,900	[420]	23,200	[660]	38,100	[1,070]
20	[1.4]	8,200	[230]	12,800	[360]	21,000	[590]	32,700	[930]	53,700	[1,510]
30	[2.1]	10,500	[300]	16,600	[470]	27,100	[770]	42,200	[1,190]	69,300	[1,930]
40	[2.8]	12,900	[370]	20,300	[570]	33,200	[940]	51,700	[1,460]	84,800	[2,370]
50	[3.4]	15,300	[430]	24,000	[680]	39,300	[1,110]	61,200	[1,730]	100,400	[2,810]
60	[4.1]	17,700	[500]	27,800	[790]	45,500	[1,290]	70,700	[2,000]	116,300	[3,250]
75	[5.2]	21,200	[600]	33,400	[950]	54,600	[1,550]	85,000	[2,410]	139,500	[3,920]
100	[6.9]	27,200	[770]	42,700	[1,210]	69,900	[1,980]	108,700	[3,080]	178,600	[5,000]
150	[10.3]	39,100	[1,110]	61,400	[1,740]	100,400	[2,840]	156,300	[4,430]	256,700	[7,200]
175	[12.1]	45,000	[1,270]	70,700	[2,000]	115,700	[3,280]	180,000	[5,100]	296,700	[8,290]
250	[17.2]	62,800	[1,780]	98,700	[2,790]	161,500	[4,570]	251,300	[7,120]	412,700	[11,580]
290	[20.0]	72,300	[2,050]	113,700	[3,220]	186,000	[5,270]	289,300	[8,190]	475,300	[13,300]

Note: All capacities are based on 14.4 psia atmospheric pressure, 14.73 psia base pressure, and 60° F base temperature.

Honeywell
THE POWER OF **CONNECTED**

Turbine Meter Capacity Table

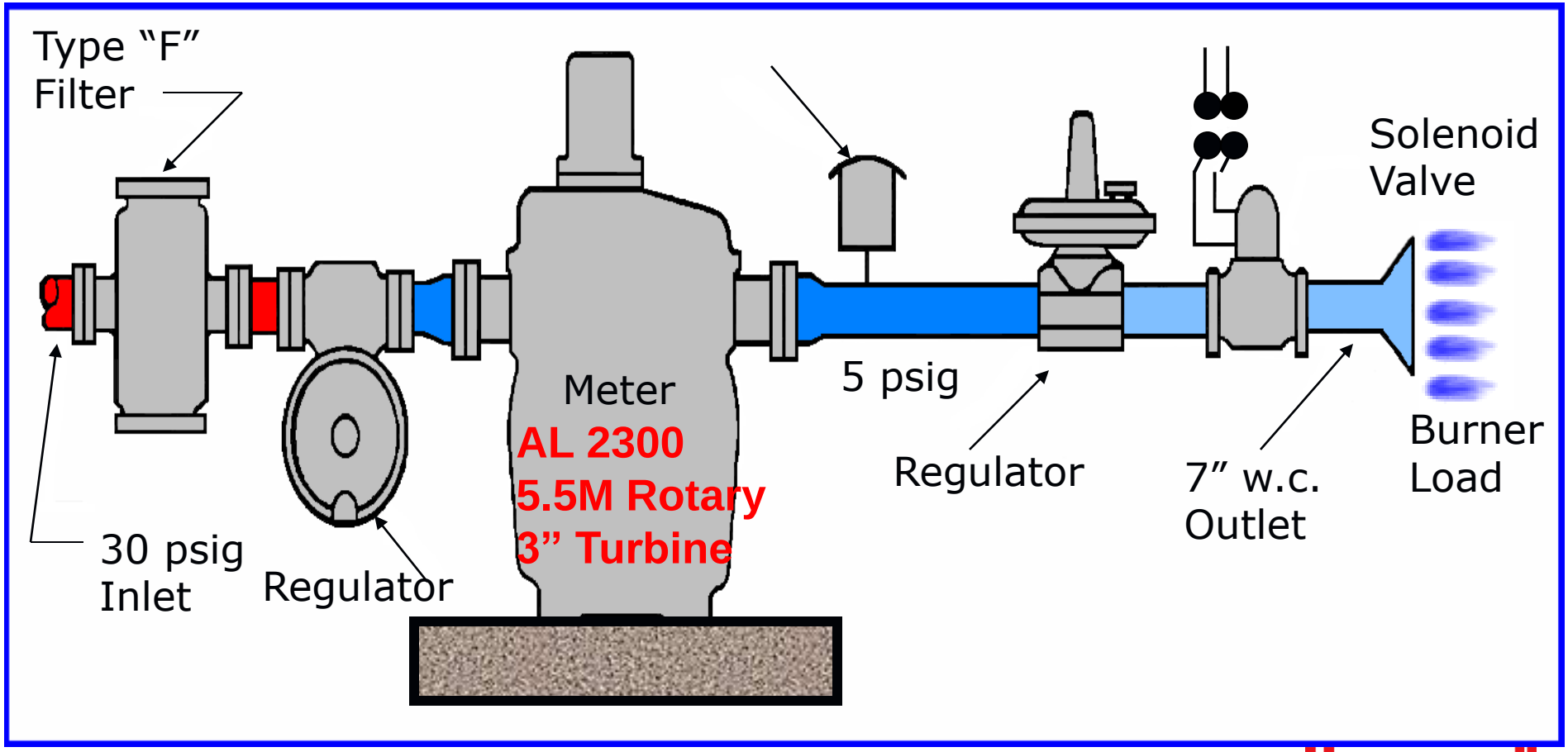
3" GT, Output Drive = 100 Cubic Feet, 45° Rotor

Line Pressure (PSIG)	Qmax MSCFH	Qmin MSCFH	Range Qmax/Qmin	Min. Actual Flow Rate MACFH	Press. Drop in W.C.
0.25	10	0.8	12	0.83	4.5
5	13	1.0	14	0.73	6.0
10	17	1.1	15	0.65	7.5
15	20	1.2	17	0.59	9.0
20	23	1.3	18	0.55	10.5
25	27	1.4	20	0.51	12.1
50	44	1.8	25	0.40	19.7
75	61	2.1	30	0.34	27.3
100	79	2.4	33	0.30	35.0
125	97	2.6	37	0.28	42.6
150	114	2.9	40	0.30	50.2
175	132	3.1	43	0.24	57.9
200	150	3.3	46	0.23	65.5
275	205	3.9	53	0.20	88.4
300	224	4.0	55	0.19	96.1
400	300	4.7	64	0.17	127.0
500	379	5.3	71	0.15	157.0
600	460	5.9	78	0.14	188.0
700	544	6.5	84	0.13	218.0
800	630	7.1	89	0.13	249.0
900	719	7.6	95	0.12	279.0
1000	810	8.1	100	0.12	310.0
1100	904	8.7	104	0.12	340.0
1200	1000	9.2	109	0.11	371.0
1300	1098	9.7	113	0.11	402.0
1400	1197	10.2	118	0.11	432.0

Note: Capacity Table values established @ base pressure of 14.73 PSIA and base temperature of 60°F; 0.60 specific gravity gas. Supercompressibility included.

Honeywell
THE POWER OF CONNECTED

Fixed Factor Meter Sets



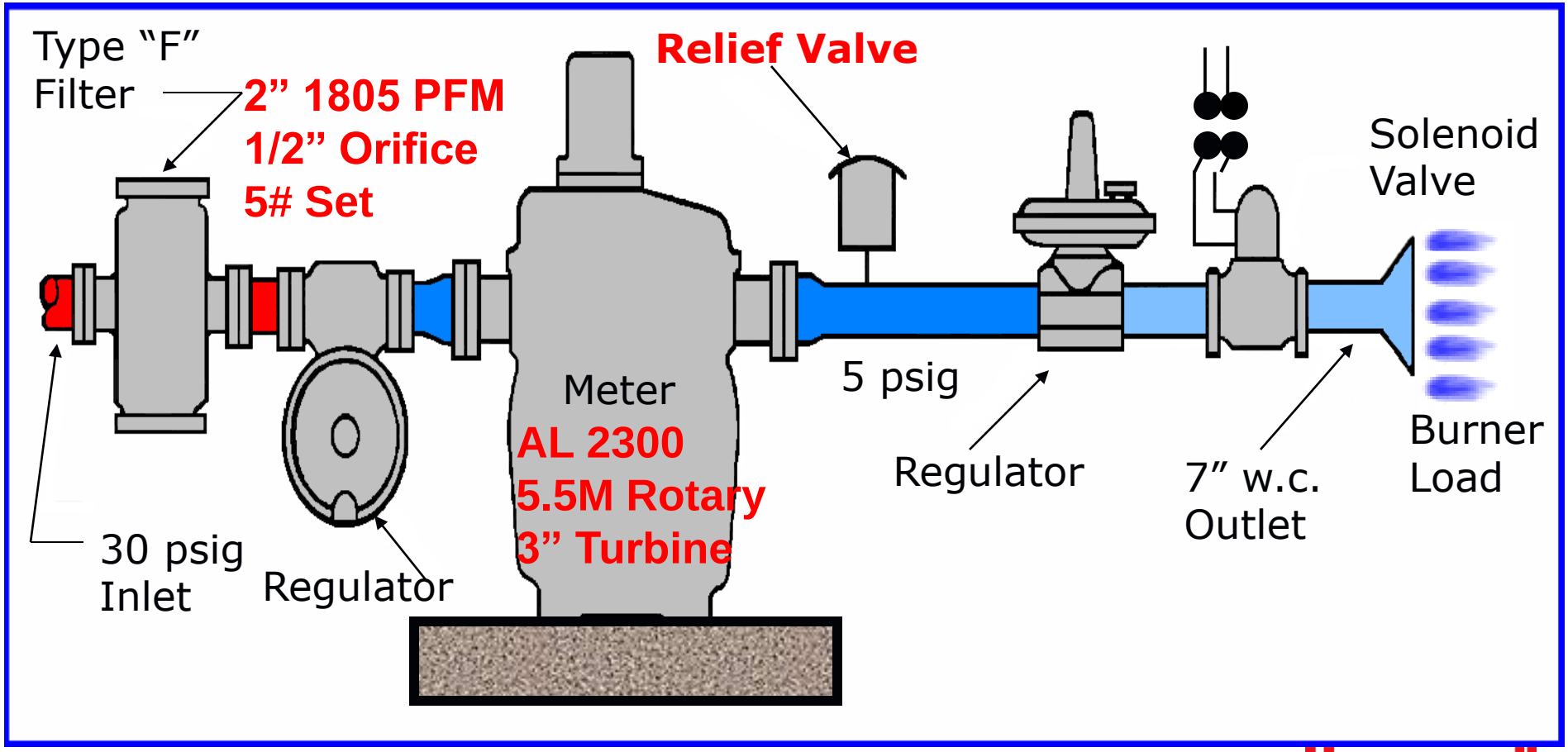
Honeywell
THE POWER OF CONNECTED

1804 PFM Pilot-Operated Regulator

CAPACITY (SCFH) 2" VALVE BODY 5 psi set, ±1% abs.								
INLET (psig)	ORIFICE							
	1/4"	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1-1/4"
10	1,300	2,400	3,900	4,200	7,400	4,400	9,600	12,300
15	1,800	3,400	5,100	6,500	11,000	9,800	16,500	22,600
20	2,100	4,000	6,300	9,800	13,400	12,000	21,600	29,600
30	2,800	6,500	8,200	17,100	18,300	21,500	30,800	43,200
40	3,400	6,700	13,400	22,400	22,400	26,300	39,800	45,600
60	5,100	11,400	17,600	32,600	34,800	32,700	54,400	40,100
80	5,900	15,600	23,200	36,100	37,000	37,300	46,000	40,700
100	7,200	18,900	28,100	28,100	25,600	18,100	46,400	
125	10,500	18,700	28,600	29,700	31,200	9,200		

Honeywell
THE POWER OF CONNECTED

Fixed Factor Meter Sets



Honeywell
THE POWER OF CONNECTED

Design a Meter Set

$Q_{connected\ Load}$ = 5,250 scfh

Maximum Inlet Pressure = 60 psig

Minimum Inlet Pressure = 30 psig

Outlet Pressure = 2 PSIG

Customer needs 7” w.c. @ Burners

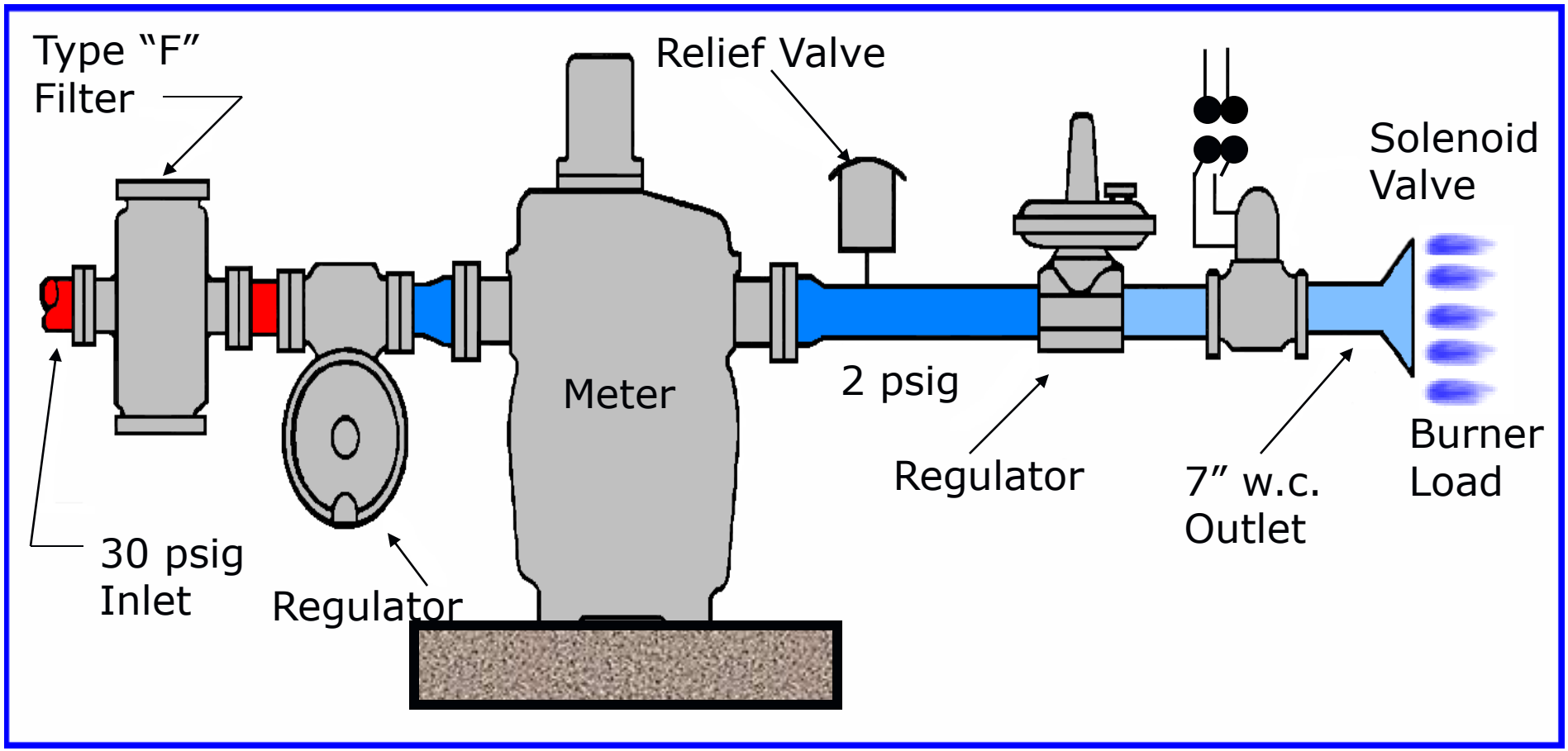
No Diversity Factor

$Q_{minimum}$ = 10 scfh

Honeywell

THE POWER OF CONNECTED

Fixed Factor Meter Sets



Honeywell
THE POWER OF CONNECTED

Diaphragm Meter Capacity Table

Meter Capacities

Diaphragm Meter Capacities * scfh (Sm^3/h)									
Line Pressure	AT-210	AT-250 AC-250 AM-250 AR-250	AL-425	AC-630	AL-800	AL-1000	AL-1400	AL-2300	AL-5000
0.25 psig (17 mBarg)	210 (5.9)	250 (7.1)	425 (12.0)	630 (17.8)	800 (22.7)	1000 (28.3)	1400 (39.6)	2300 (65.1)	5000 (141.6)
2 psig (14 mBarg)	424 (12.0)	550 (15.6)	955 (27.0)	1390 (39.4)	1850 (52.4)	2400 (68.0)	3265 (92.5)	5440 (154.0)	12000 (339.8)
5 psig (345 mBarg)	462 (13.1)	593 (16.8)	1100 (31.1)	1515 (42.9)	2100 (59.5)	2700 (76.5)	3700 (104.8)	6200 (175.6)	13500 (382.3)
10 psig (690 mBarg)	–	–	1350 (38.2)	1710 (48.4)	2600 (73.6)	3400 (96.3)	4600 (130.3)	7700 (218.1)	1700 (481.4)
20 psig (1.4 Barg)	–	–	1700 (48.1)	2010 (56.9)	3200 (90.6)	4100 (116.1)	5600 (158.6)	9400 (266.2)	20600 (583.4)
25 psig (1.7 Barg)	–	–	1880 (53.2)	2160 (61.2)	3500 (99.1)	4600 (130.3)	6200 (175.6)	10400 (294.5)	23000 (654.4)
50 psig (3.4 Barg)	–	–	–	–	5100 (144.4)	6600 (186.9)	9000 (254.9)	15000 (424.8)	33000 (934.6)
75 psig (5.2 Barg)	–	–	–	–	6600 (186.9)	8540 (241.8)	11650 (329.9)	19400 (549.4)	42700 (1209.1)
100 psig (6.9 Barg)	–	–	–	–	7800 (220.9)	10100 (286.0)	13800 (390.8)	23000 (651.4)	50500 (1,430.2)

* Capacity data based upon natural gas with specific gravity of 0.60.

Honeywell
THE POWER OF CONNECTED

Rotary Meter Capacity Table

SIZING CHART											
Model		3.5M/G65		5.5M/G100		9M/G160		14M/G250		23M/G400	
psig	[Barg]	Corrected Capacity in scfh [sm^3/h]									
0.25	[0.0]	3,500	[100]	5,500	[160]	9,000	[250]	14,000	[400]	23,000	[650]
2	[0.1]	3,900	[110]	6,100	[170]	10,000	[280]	15,600	[440]	25,300	[715]
5	[0.3]	4,600	[130]	7,200	[200]	11,900	[340]	18,400	[520]	30,400	[850]
10	[0.7]	5,800	[160]	9,100	[260]	14,900	[420]	23,200	[660]	38,100	[1,070]
20	[1.4]	8,200	[230]	12,800	[360]	21,000	[590]	32,700	[930]	53,700	[1,510]
30	[2.1]	10,500	[300]	16,600	[470]	27,100	[770]	42,200	[1,190]	69,300	[1,930]
40	[2.8]	12,900	[370]	20,300	[570]	33,200	[940]	51,700	[1,460]	84,800	[2,370]
50	[3.4]	15,300	[430]	24,000	[680]	39,300	[1,110]	61,200	[1,730]	100,400	[2,810]
60	[4.1]	17,700	[500]	27,800	[790]	45,500	[1,290]	70,700	[2,000]	116,300	[3,250]
75	[5.2]	21,200	[600]	33,400	[950]	54,600	[1,550]	85,000	[2,410]	139,500	[3,920]
100	[6.9]	27,200	[770]	42,700	[1,210]	69,900	[1,980]	108,700	[3,080]	178,600	[5,000]
150	[10.3]	39,100	[1,110]	61,400	[1,740]	100,400	[2,840]	156,300	[4,430]	256,700	[7,200]
175	[12.1]	45,000	[1,270]	70,700	[2,000]	115,700	[3,280]	180,000	[5,100]	296,700	[8,290]
250	[17.2]	62,800	[1,780]	98,700	[2,790]	161,500	[4,570]	251,300	[7,120]	412,700	[11,580]
290	[20.0]	72,300	[2,050]	113,700	[3,220]	186,000	[5,270]	289,300	[8,190]	475,300	[13,300]

Note: All capacities are based on 14.4 psia atmospheric pressure, 14.73 psia base pressure, and 60° F base temperature.

Honeywell
THE POWER OF **CONNECTED**

Turbine Meter Capacity Table

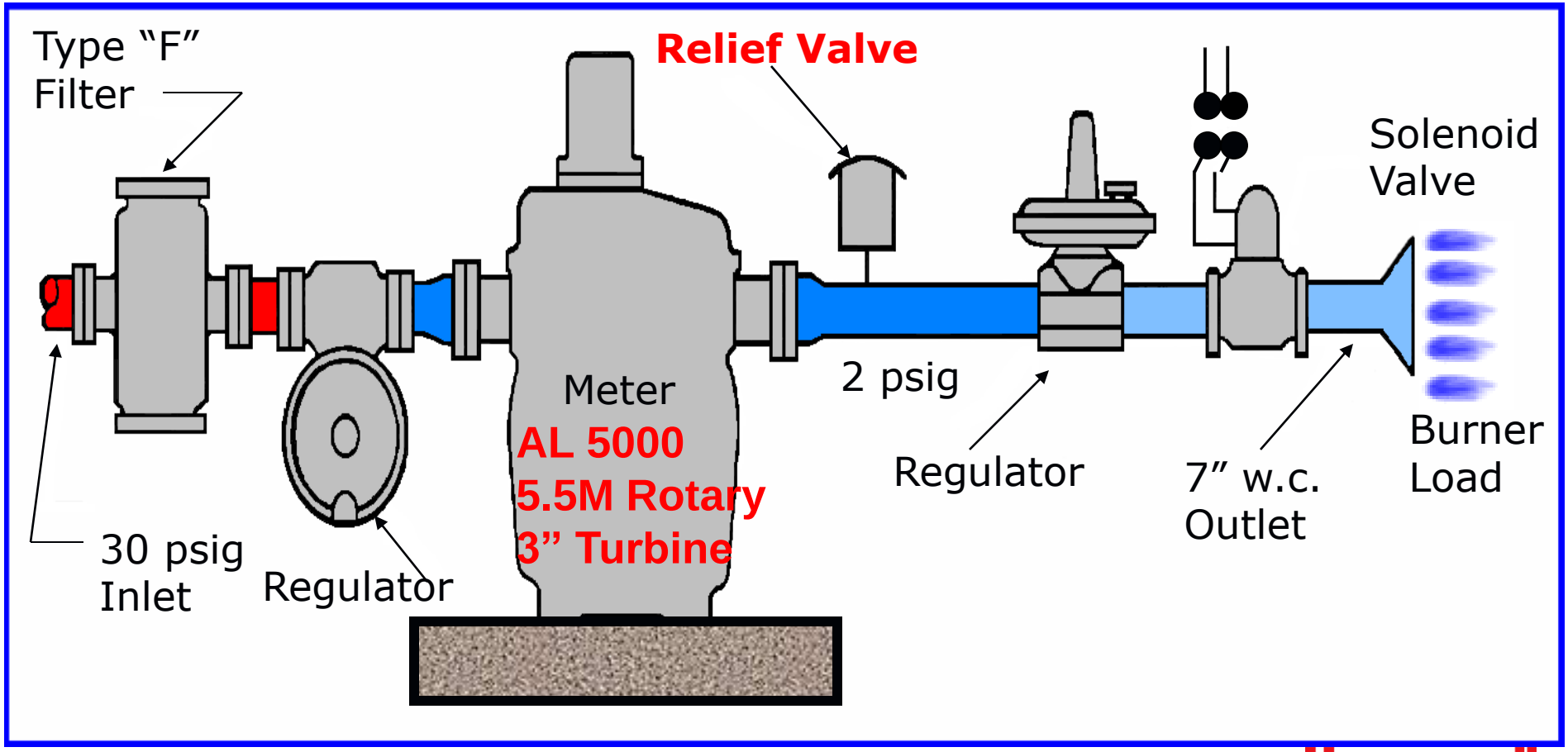
3" GT, Output Drive = 100 Cubic Feet, 45° Rotor

Line Pressure (PSIG)	Qmax MSCFH	Qmin MSCFH	Range Qmax/Qmin	Min. Actual Flow Rate MACFH	Press. Drop in W.C.
0.25	10	0.8	12	0.83	4.5
5	13	1.0	14	0.73	6.0
10	17	1.1	15	0.65	7.5
15	20	1.2	17	0.59	9.0
20	23	1.3	18	0.55	10.5
25	27	1.4	20	0.51	12.1
50	44	1.8	25	0.40	19.7
75	61	2.1	30	0.34	27.3
100	79	2.4	33	0.30	35.0
125	97	2.6	37	0.28	42.6
150	114	2.9	40	0.30	50.2
175	132	3.1	43	0.24	57.9
200	150	3.3	46	0.23	65.5
275	205	3.9	53	0.20	88.4
300	224	4.0	55	0.19	96.1
400	300	4.7	64	0.17	127.0
500	379	5.3	71	0.15	157.0
600	460	5.9	78	0.14	188.0
700	544	6.5	84	0.13	218.0
800	630	7.1	89	0.13	249.0
900	719	7.6	95	0.12	279.0
1000	810	8.1	100	0.12	310.0
1100	904	8.7	104	0.12	340.0
1200	1000	9.2	109	0.11	371.0
1300	1098	9.7	113	0.11	402.0
1400	1197	10.2	118	0.11	432.0

Note: Capacity Table values established @ base pressure of 14.73 PSIA and base temperature of 60°F; 0.60 specific gravity gas. Supercompressibility included.

Honeywell
THE POWER OF CONNECTED

Fixed Factor Meter Sets



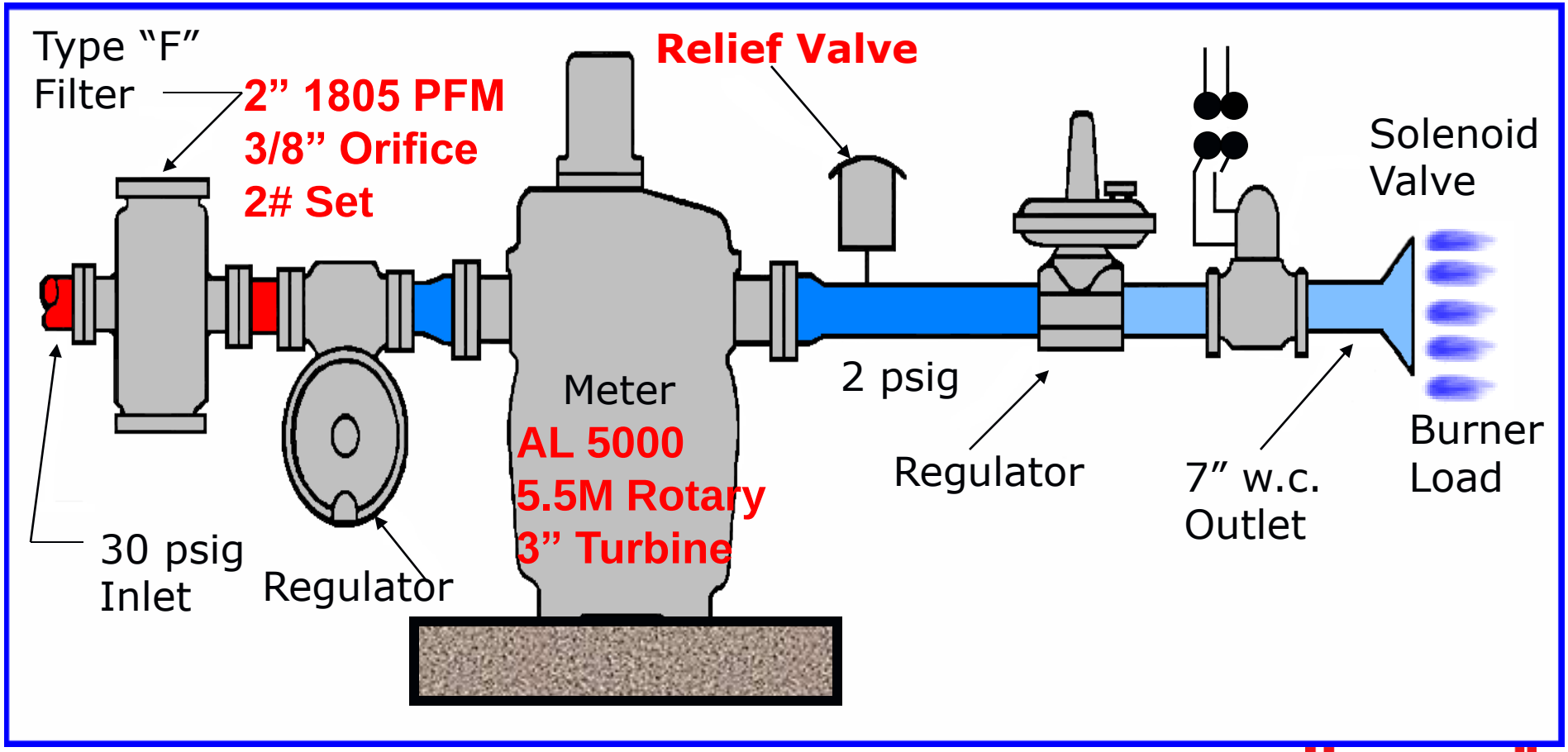
Honeywell
THE POWER OF CONNECTED

1805 PFM Pilot-Operated Regulator

CAPACITY (SCFH) 2" VALVE BODY 2 psi set, ±1% abs.								
INLET (psig)	ORIFICE							
	1/4"	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1-1/4"
5	1,100	2,300	3,400	3,200	4,400	4,300	6,000	10,100
10	1,700	3,800	5,800	8,200	10,700	11,600	13,300	16,800
15	2,400	5,200	7,400	11,600	14,300	12,900	18,500	25,300
20	2,900	5,700	9,200	15,500	18,100	18,200	23,200	31,700
30	3,600	7,600	13,300	20,100	26,600	29,300	31,700	40,800
40	4,400	9,300	15,700	26,100	32,600	33,500	39,800	41,100
60	6,000	13,200	14,500	30,500	41,700	21,200	52,900	46,200
80	7,600	16,900	18,400	25,800	35,200	20,700	57,500	30,500
100	9,300	14,700	22,300	18,800	25,600	25,100	55,700	
125	8,700	17,900	27,100	22,900	31,200	30,600		

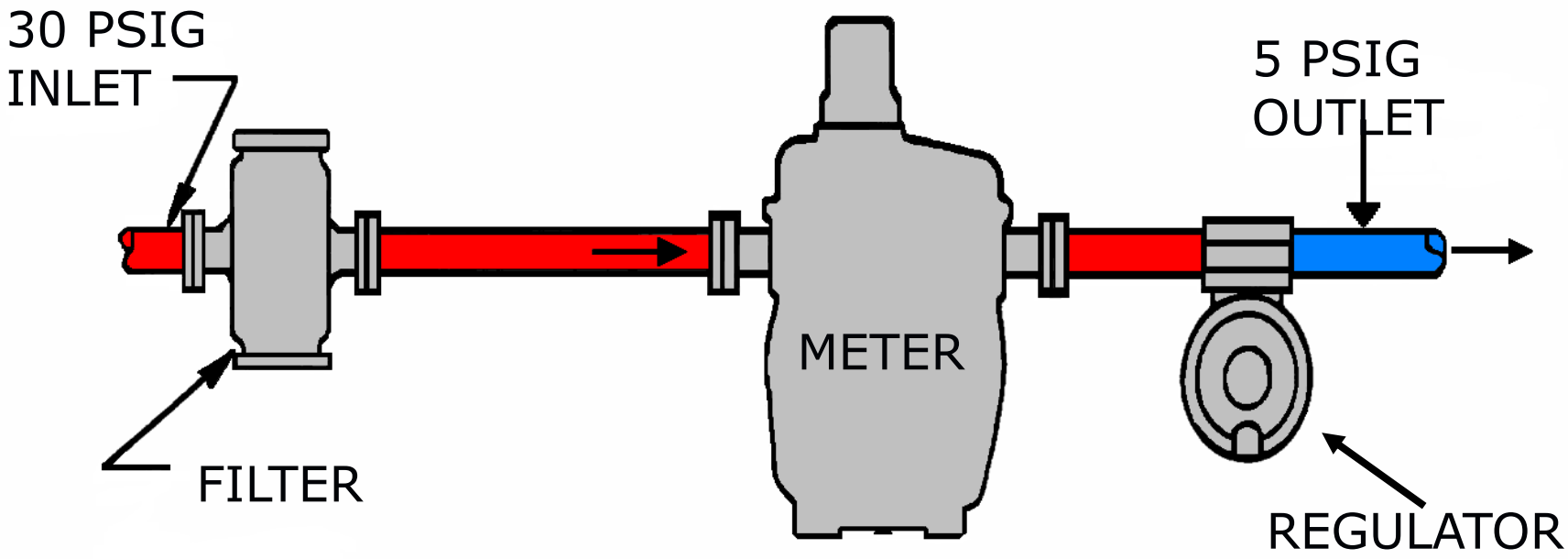
Honeywell
THE POWER OF CONNECTED

Fixed Factor Meter Sets



Honeywell
THE POWER OF CONNECTED

Line Pressure Meter Sets



Honeywell
THE POWER OF CONNECTED

Diaphragm Meter Capacity Table

Meter Capacities

Diaphragm Meter Capacities * scfh (Sm^3/h)									
Line Pressure	AT-210	AT-250 AC-250 AM-250 AR-250	AL-425	AC-630	AL-800	AL-1000	AL-1400	AL-2300	AL-5000
0.25 psig (17 mBarg)	210 (5.9)	250 (7.1)	425 (12.0)	630 (17.8)	800 (22.7)	1000 (28.3)	1400 (39.6)	2300 (65.1)	5000 (141.6)
2 psig (14 mBarg)	424 (12.0)	550 (15.6)	955 (27.0)	1390 (39.4)	1850 (52.4)	2400 (68.0)	3265 (92.5)	5440 (154.0)	12000 (339.8)
5 psig (345 mBarg)	462 (13.1)	593 (16.8)	1100 (31.1)	1515 (42.9)	2100 (59.5)	2700 (76.5)	3700 (104.8)	6200 (175.6)	13500 (382.3)
10 psig (690 mBarg)	–	–	1350 (38.2)	1710 (48.4)	2600 (73.6)	3400 (96.3)	4600 (130.3)	7700 (218.1)	1700 (481.4)
20 psig (1.4 Barg)	–	–	1700 (48.1)	2010 (56.9)	3200 (90.6)	4100 (116.1)	5600 (158.6)	9400 (266.2)	20600 (583.4)
25 psig (1.7 Barg)	–	–	1880 (53.2)	2160 (61.2)	3500 (99.1)	4600 (130.3)	6200 (175.6)	10400 (294.5)	23000 (654.4)
50 psig (3.4 Barg)	–	–	–	–	5100 (144.4)	6600 (186.9)	9000 (254.9)	15000 (424.8)	33000 (934.6)
75 psig (5.2 Barg)	–	–	–	–	6600 (186.9)	8540 (241.8)	11650 (329.9)	19400 (549.4)	42700 (1209.1)
100 psig (6.9 Barg)	–	–	–	–	7800 (220.9)	10100 (286.0)	13800 (390.8)	23000 (651.4)	50500 (1,430.2)

* Capacity data based upon natural gas with specific gravity of 0.60.

Honeywell
THE POWER OF CONNECTED

Rotary Meter Capacity Table

SIZING CHART											
Model		3.5M/G65		5.5M/G100		9M/G160		14M/G250		23M/G400	
psig	[Barg]	Corrected Capacity in scfh [sm^3/h]									
0.25	[0.0]	3,500	[100]	5,500	[160]	9,000	[250]	14,000	[400]	23,000	[650]
2	[0.1]	3,900	[110]	6,100	[170]	10,000	[280]	15,600	[440]	25,300	[715]
5	[0.3]	4,600	[130]	7,200	[200]	11,900	[340]	18,400	[520]	30,400	[850]
10	[0.7]	5,800	[160]	9,100	[260]	14,900	[420]	23,200	[660]	38,100	[1,070]
20	[1.4]	8,200	[230]	12,800	[360]	21,000	[590]	32,700	[930]	53,700	[1,510]
30	[2.1]	10,500	[300]	16,600	[470]	27,100	[770]	42,200	[1,190]	69,300	[1,930]
40	[2.8]	12,900	[370]	20,300	[570]	33,200	[940]	51,700	[1,460]	84,800	[2,370]
50	[3.4]	15,300	[430]	24,000	[680]	39,300	[1,110]	61,200	[1,730]	100,400	[2,810]
60	[4.1]	17,700	[500]	27,800	[790]	45,500	[1,290]	70,700	[2,000]	116,300	[3,250]
75	[5.2]	21,200	[600]	33,400	[950]	54,600	[1,550]	85,000	[2,410]	139,500	[3,920]
100	[6.9]	27,200	[770]	42,700	[1,210]	69,900	[1,980]	108,700	[3,080]	178,600	[5,000]
150	[10.3]	39,100	[1,110]	61,400	[1,740]	100,400	[2,840]	156,300	[4,430]	256,700	[7,200]
175	[12.1]	45,000	[1,270]	70,700	[2,000]	115,700	[3,280]	180,000	[5,100]	296,700	[8,290]
250	[17.2]	62,800	[1,780]	98,700	[2,790]	161,500	[4,570]	251,300	[7,120]	412,700	[11,580]
290	[20.0]	72,300	[2,050]	113,700	[3,220]	186,000	[5,270]	289,300	[8,190]	475,300	[13,300]

Note: All capacities are based on 14.4 psia atmospheric pressure, 14.73 psia base pressure, and 60° F base temperature.

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Turbine Meter Capacity Table

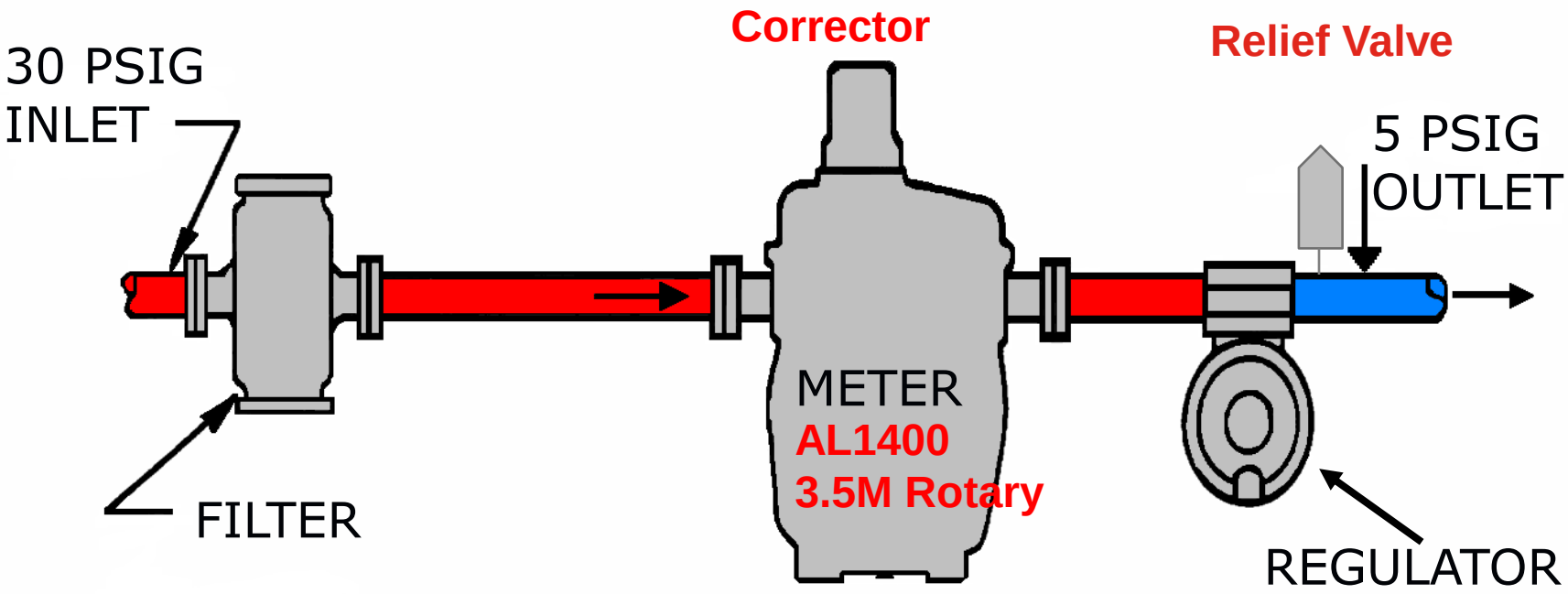
3" GT, Output Drive = 100 Cubic Feet, 45° Rotor

Line Pressure (PSIG)	Qmax MSCFH	Qmin MSCFH	Range Qmax/Qmin	Min. Actual Flow Rate MACFH	Press. Drop in W.C.
0.25	10	0.8	12	0.83	4.5
5	13	1.0	14	0.73	6.0
10	17	1.1	15	0.65	7.5
15	20	1.2	17	0.59	9.0
20	23	1.3	18	0.55	10.5
25	27	1.4	20	0.51	12.1
50	44	1.8	25	0.40	19.7
75	61	2.1	30	0.34	27.3
100	79	2.4	33	0.30	35.0
125	97	2.6	37	0.28	42.6
150	114	2.9	40	0.30	50.2
175	132	3.1	43	0.24	57.9
200	150	3.3	46	0.23	65.5
275	205	3.9	53	0.20	88.4
300	224	4.0	55	0.19	96.1
400	300	4.7	64	0.17	127.0
500	379	5.3	71	0.15	157.0
600	460	5.9	78	0.14	188.0
700	544	6.5	84	0.13	218.0
800	630	7.1	89	0.13	249.0
900	719	7.6	95	0.12	279.0
1000	810	8.1	100	0.12	310.0
1100	904	8.7	104	0.12	340.0
1200	1000	9.2	109	0.11	371.0
1300	1098	9.7	113	0.11	402.0
1400	1197	10.2	118	0.11	432.0

Note: Capacity Table values established @ base pressure of 14.73 PSIA and base temperature of 60°F; 0.60 specific gravity gas. Supercompressibility included.

Honeywell
THE POWER OF CONNECTED

Line Pressure Meter Sets



Honeywell
THE POWER OF CONNECTED

Industrial Regulator Capacity Table

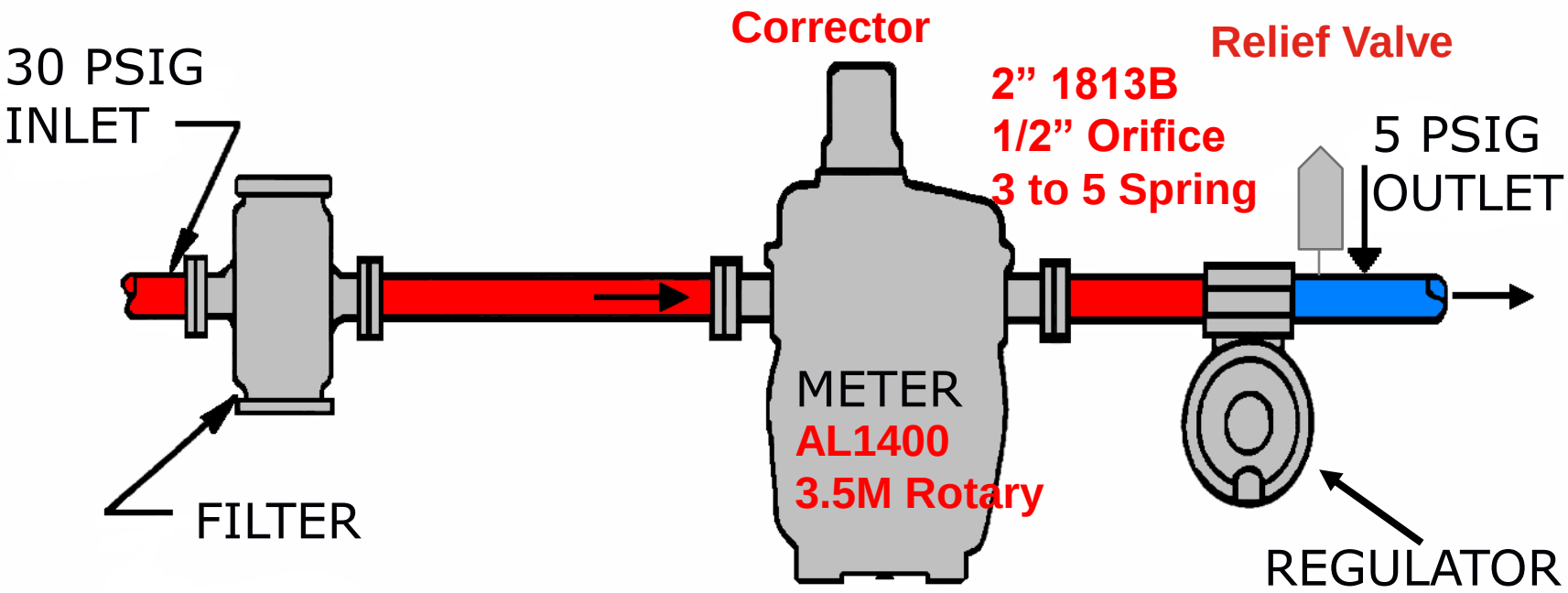
Inlet psi	Orifice Size – All Models With Silver Holder							
	1-1/4"	1"	7/8"	3/4"	5/8"	1/2"	3/8"	1/4"
5								
10	7,000	5,600	4,800	4,800	3,700	3,100	2,200	1,200
15	9,500	7,600	6,200	6,200	4,800	4,200	3,000	1,850
20	11,800	9,750	7,600	7,600	6,000	5,300	3,800	2,200
30		12,700	10,500	10,500	8,300	7,200	5,000	2,900
40			13,000	13,000	9,400	8,700	6,500	3,500
60			17,200	17,200	12,700	12,000	8,900	4,900
80				20,000	16,000	15,200	10,800	6,200
100							12,700	7,500
125								8,100

SPRING NO.
71424P023

3 psi to 5 psi
Set: 5 psi
Droop: 1 psi

Honeywell
THE POWER OF CONNECTED

Line Pressure Meter Sets



Honeywell
THE POWER OF CONNECTED

Station Design

Measurement
- Diaphragm
- Rotary
- Turbine
- Ultrasonic
- Orifice
- Other
- Multiple Runs
- By-pass

Regulation

Low Pressure

Fixed Factor

Line Pressure

Pressure Protection

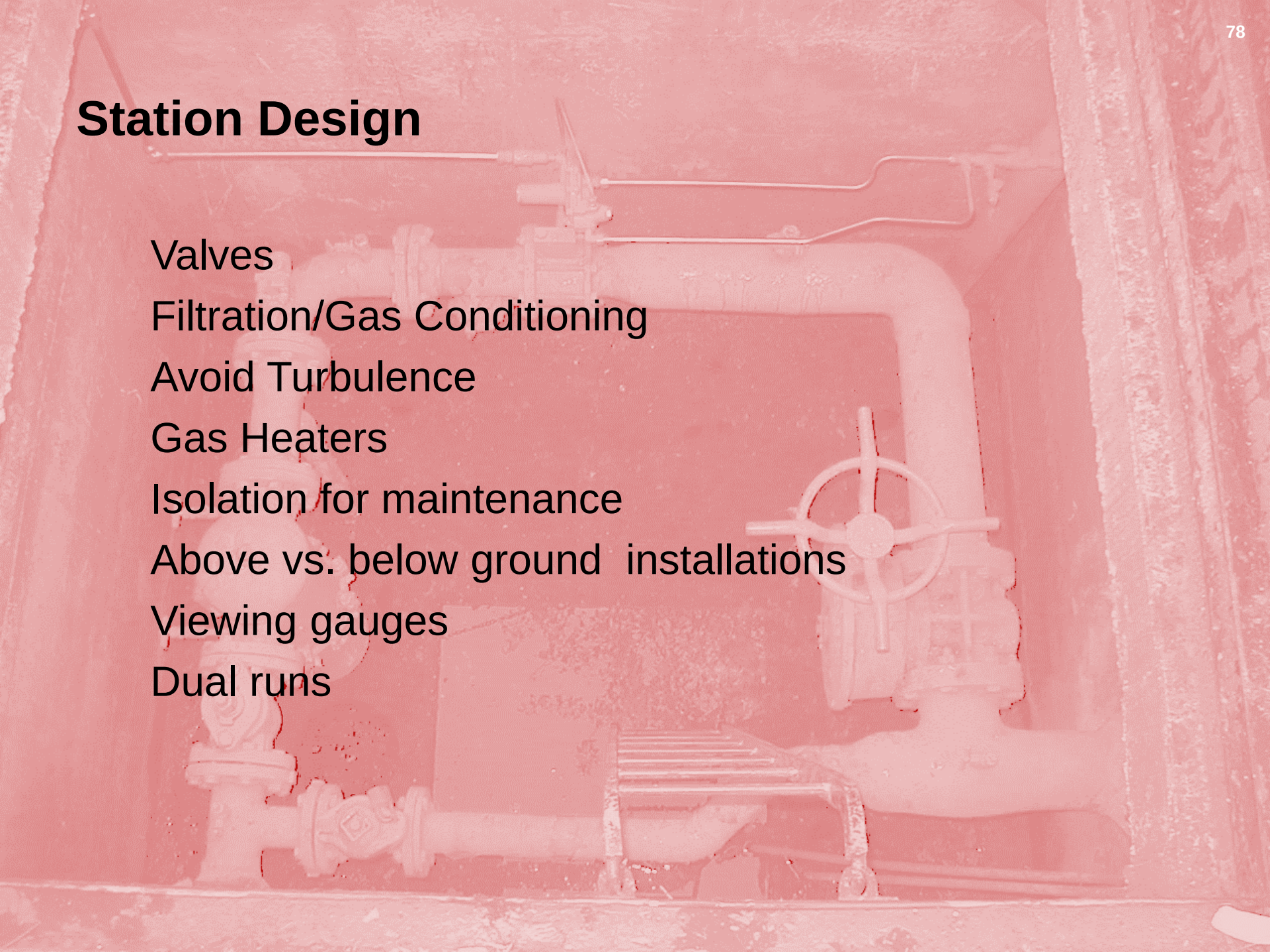
Station Design

- Cathodic Protection
- Security
- Communication
- Valves
- Other Equipment
  - BTU Analyzers
  - Odorization
- Maintenance
  - Training
  - Tools/Materials

Station Design

- Consider Installation, Operational &, Maintenance Requirements
- Gauge Openings
- Standardize
- As-built drawings
- Protection
  - Weather
  - Electrical
  - Vandalism
  - Damage from Outside Forces

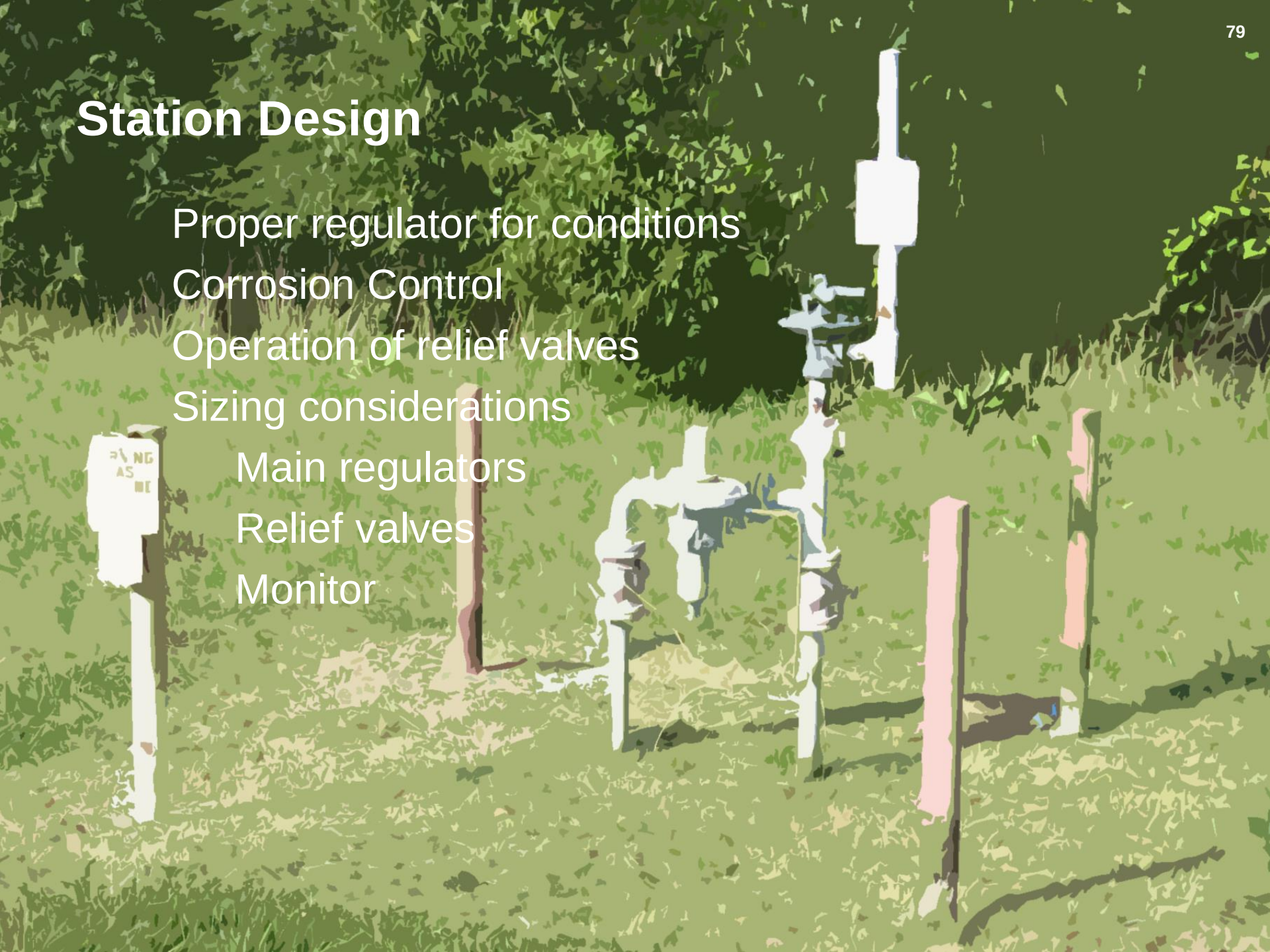
Station Design



- Valves
- Filtration/Gas Conditioning
- Avoid Turbulence
- Gas Heaters
- Isolation for maintenance
- Above vs. below ground installations
- Viewing gauges
- Dual runs

Station Design

- Proper regulator for conditions
- Corrosion Control
- Operation of relief valves
- Sizing considerations
  - Main regulators
  - Relief valves
  - Monitor



Station Design

- Piping
  - Supports
    - Main runs
    - Relief valve
    - Control Piping
  - Gas Velocity
    - Location of changes in pipe size
    - < 70 ft/sec - inlet
    - < 200 ft/sec - outlet
  - Long radius ells
  - Control piping - 1/4” or 1/2”

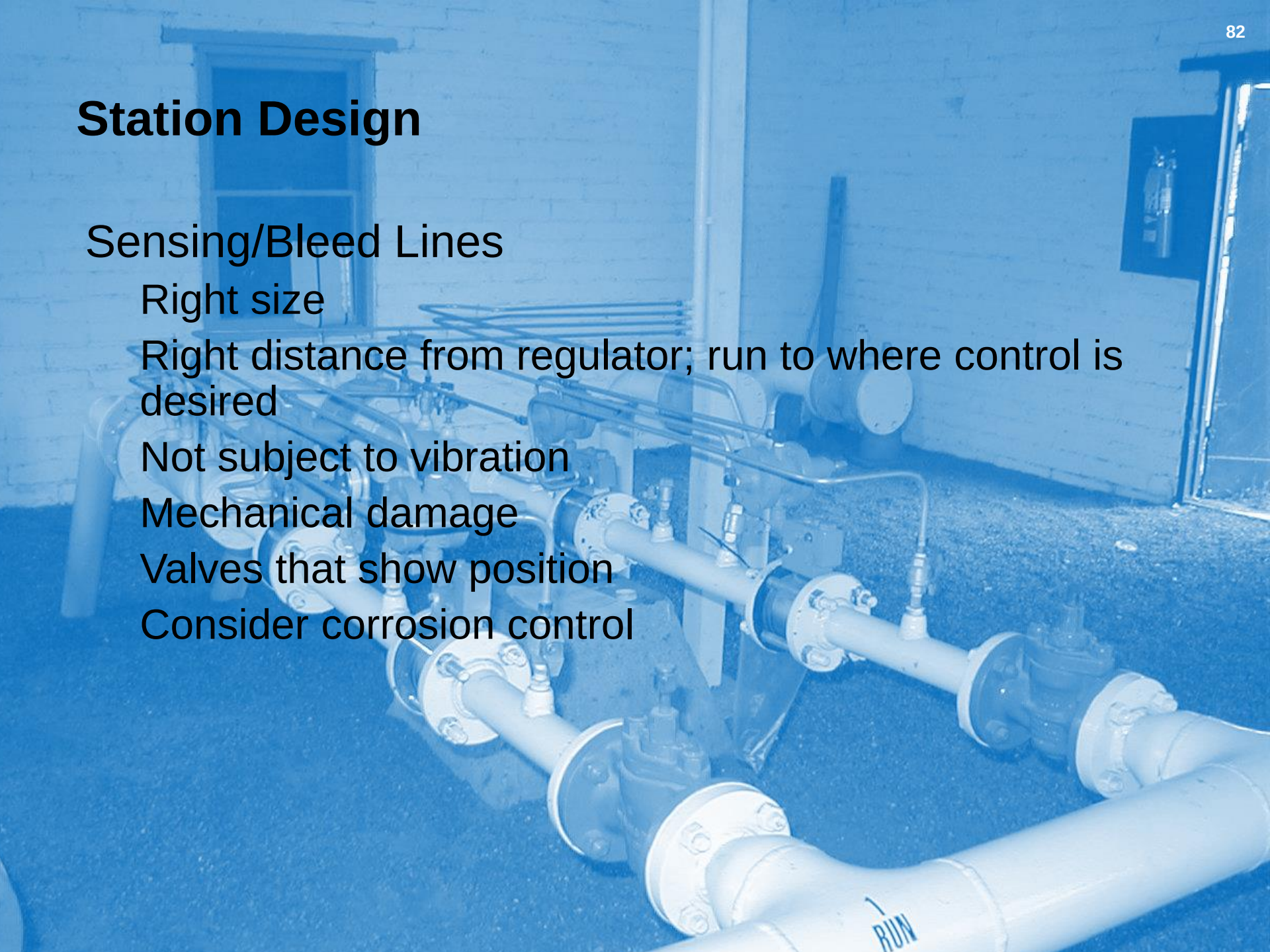
Station Design

- Filters
  - Use where needed
  - Differential indicators
  - Maintenance
    - Schedule
    - Clearance
  - Serving pilot regulators

Station Design

Sensing/Bleed Lines

- Right size
- Right distance from regulator; run to where control is desired
- Not subject to vibration
- Mechanical damage
- Valves that show position
- Consider corrosion control



Station Maintenance

1. Schedule
2. Tools
3. Training
4. Parts
5. Drawings
6. Correct lubricants
7. Depressurize
8. Housekeeping

Station Maintenance

9. Avoid excessive grease & sealing compound
10. Check for free movement in linkages
11. Check for leakage
12. Check valves in proper position

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Questions?

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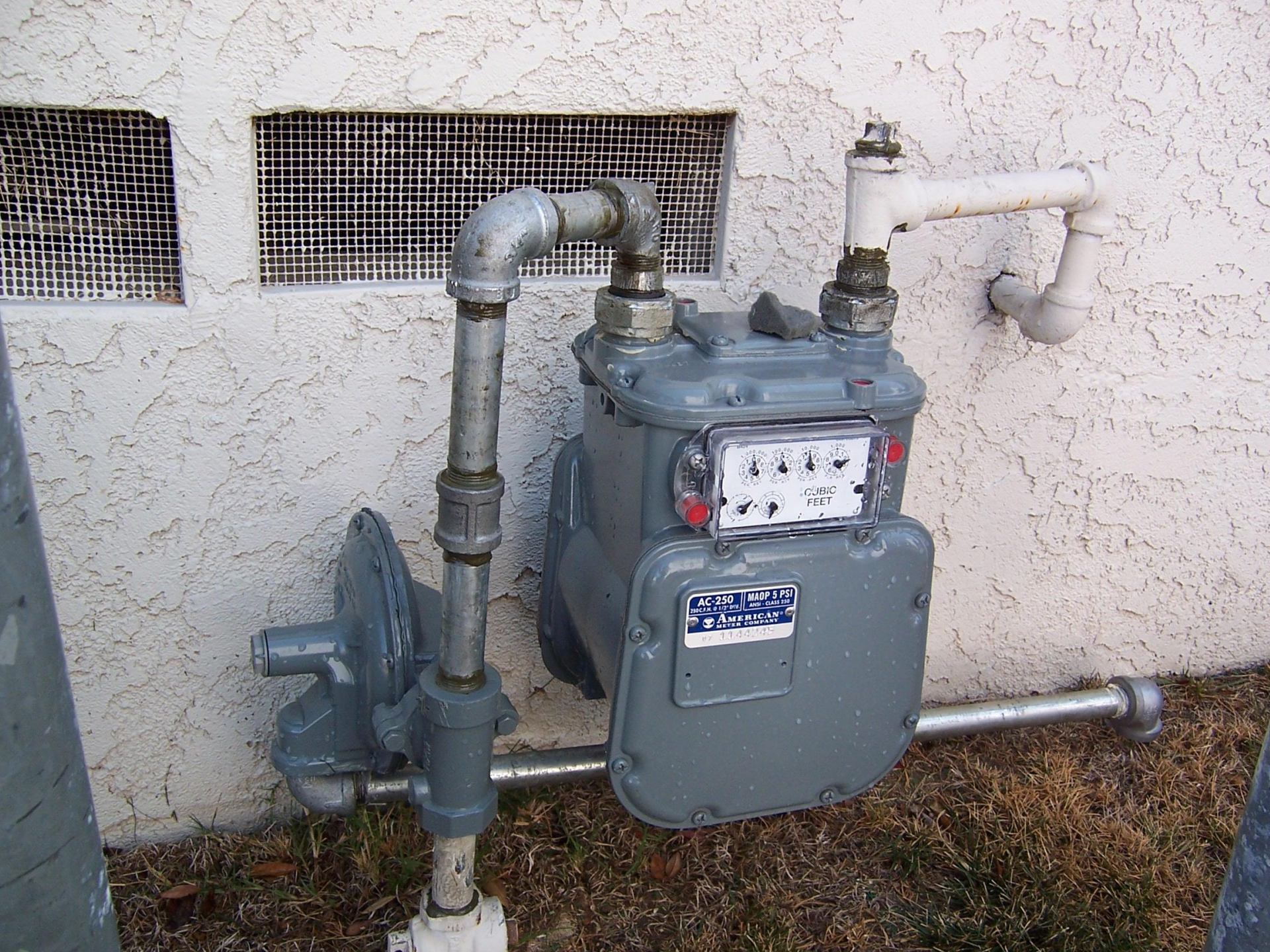
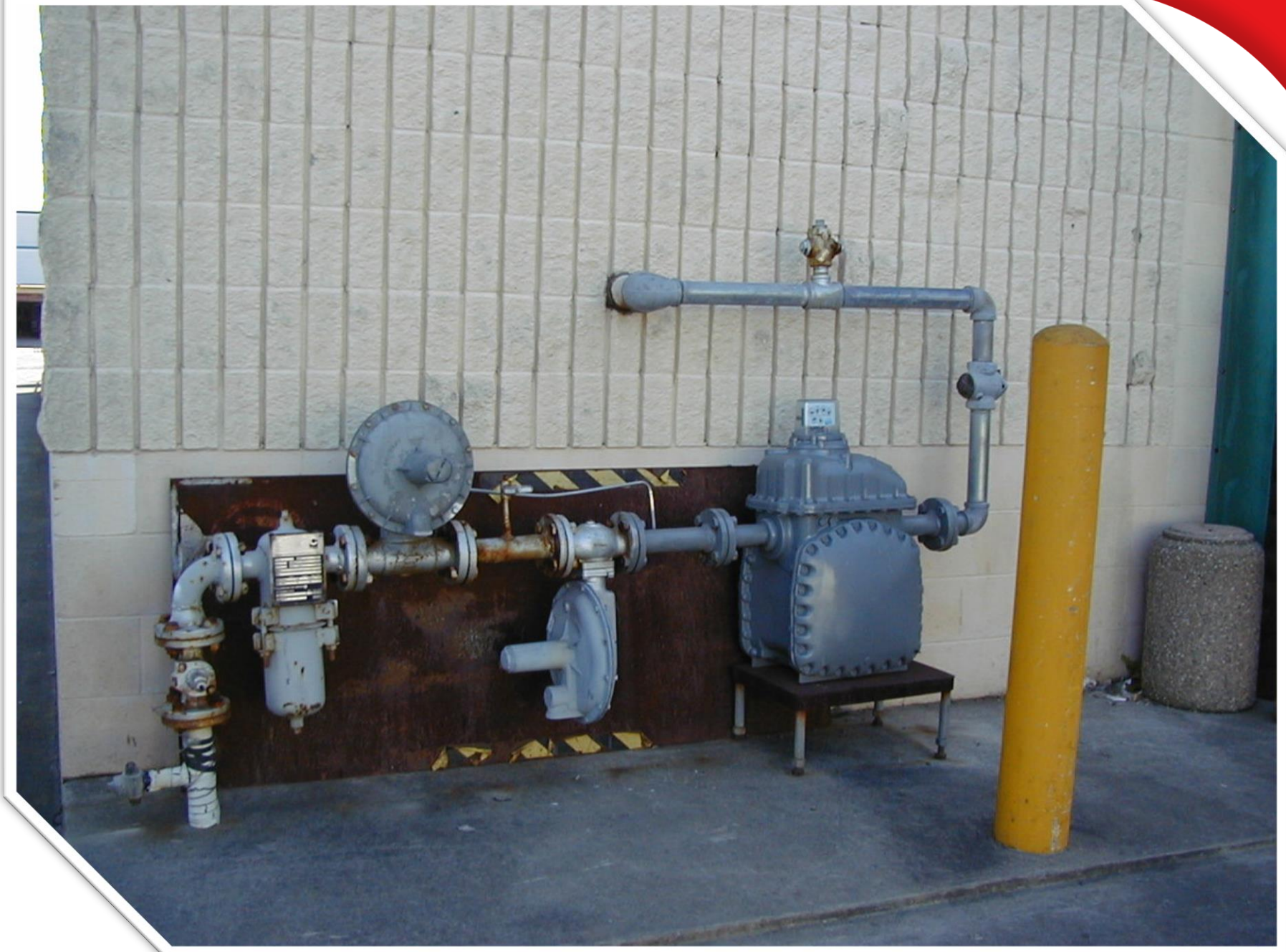
Sprague


CUBIC
FEET
AC-250
MAOP 5 PSI
AMERICAN
METER COMPANY



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