

# Controlling and Monitoring Gas Pressures and Flows

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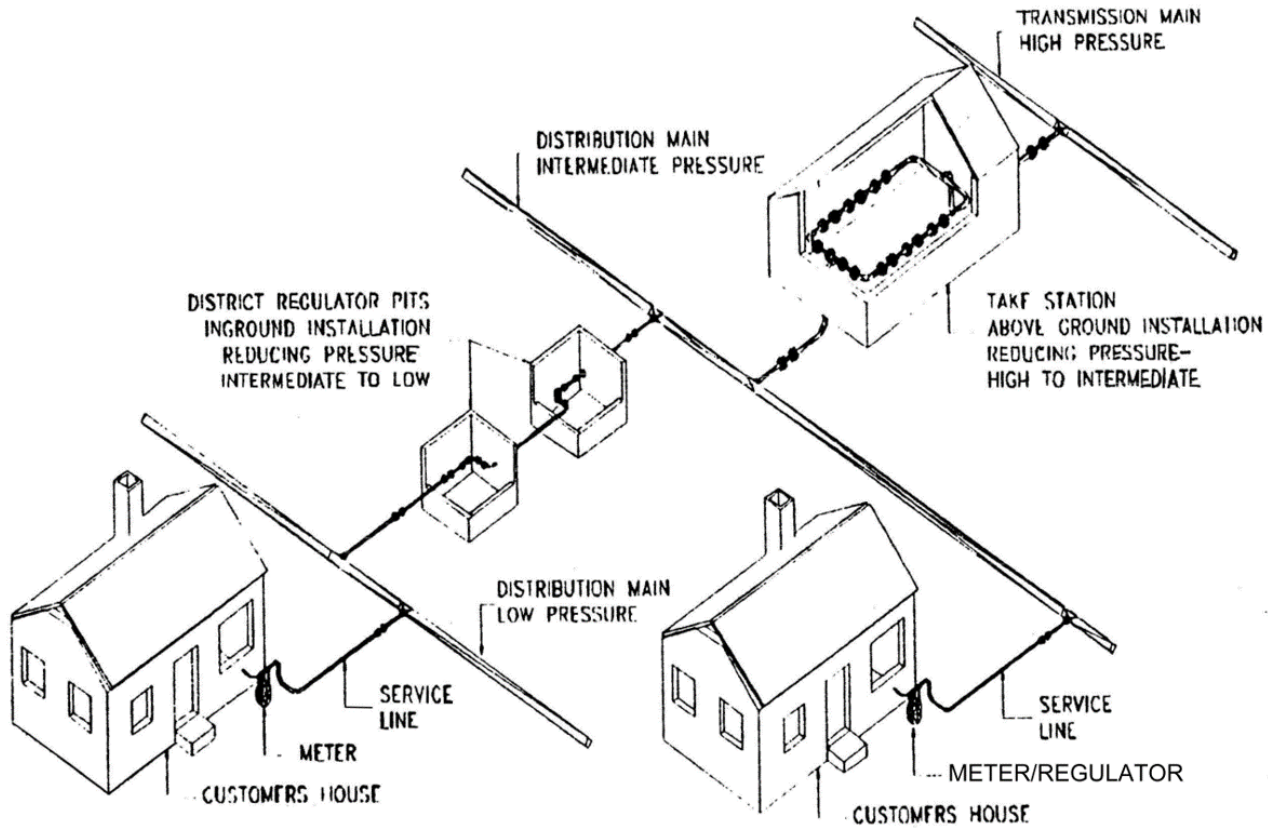


- ***Valves and their operating characteristics.***
- ***Awareness of valve locations.***
- ***Regulators and their operating principles.***
- ***Over pressure protection devices and their settings.***
- ***Flow control vs. pressure control.***
- ***Gas heating principles.***
- ***Remote monitoring and control of gas systems.***
- ***Abnormal Operating Conditions (AOCs).***

# Gas Distribution System



## Typical Natural Gas Distribution System





- A valve controls the flow of gas or liquid through a pipe.
- Different types of valves are used in different applications.
- Valves are classified as full port or restricted port.
- Valves are categorized for maintenance as critical and non-emergency.
- Critical valves must be checked for access and operation once a calendar year not to exceed 15 months (Department of Transportation mandated).
- Valve failure can result in leaks or loss of system control.

# Valves

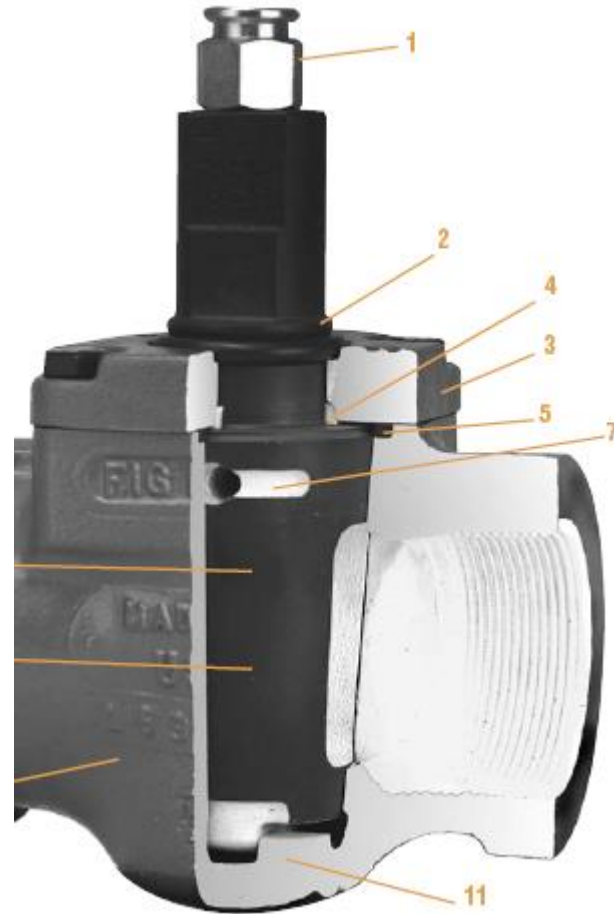


- Valves are usually made of Steel, Cast Iron, or plastic.
- Most steel or cast iron valves require lubrication.
- Plastic valves need no lubrication, but must be checked for proper operation.
- Almost all valves have similar parts, with minor variations.

# Plug Valves



- Plug valves are typically a quarter turn valve.
- Restricted port valve.
- Uses a cylindrical or tapered plug to control flow. Plug turns inside the valve to allow more or less flow straight through the valve.
- Gear operated plugs valves require multiple turns to open or close.



# Ball Valves



- Ball Valves are a full port valve.
- Quarter turn to open or close. May be gear operated, gear operated valves require multiple turns to achieve full travel.
- Very similar to plug valves, except the ball is round rather than cylindrical.
- Some ball valves are made of plastic.



# Butterfly Valves



- Quarter turn valves that have a disk that turns inside the body of the valve to control flow.
- Restricted port valve.
- Similar to gate valves, except that, in a butterfly valve, the disk turns rather than raising or lowering.
- Flow goes straight through the valve.

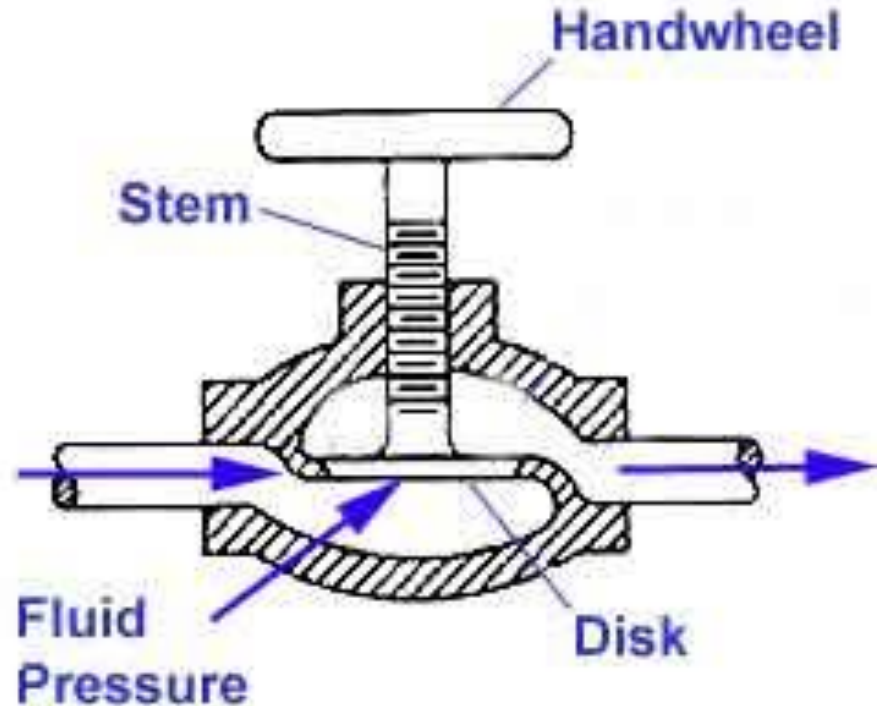




# Globe Valves



- Multi-turn valves that operate by raising and lowering a horizontal disc off or onto a seat below.
- Restricted port valve.
- Gas flow changes direction as it passes through the valve.



# Gate Valves



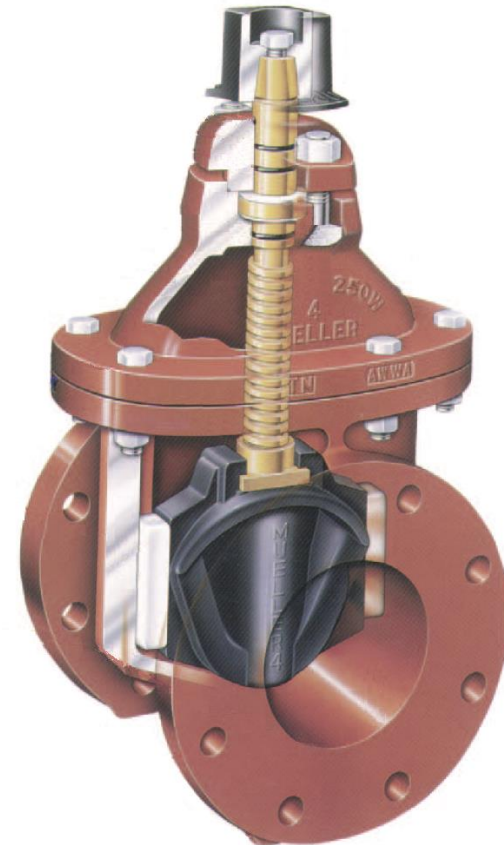
- Multi-turn valves that operates by placing a vertical metal disc, called a gate, across the opening of a pipe with valve seats on both sides.
- Full port valve.
- Gate is raised to allow flow or lowered to stop flow.
- Gas flows straight through the valve.



# Wedge Valves



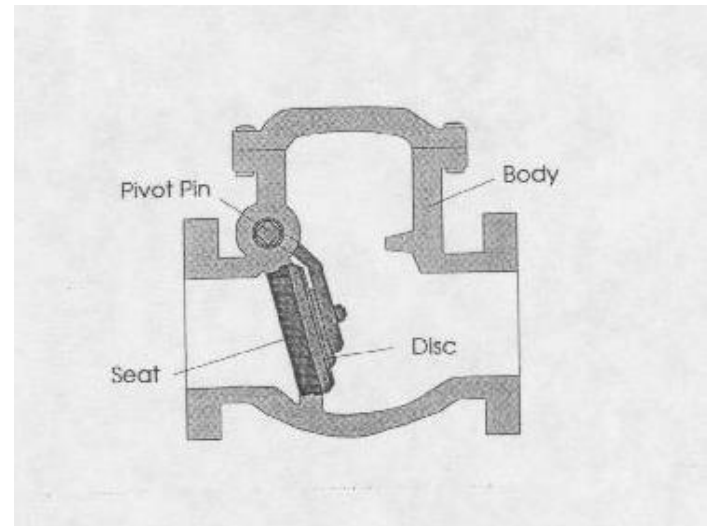
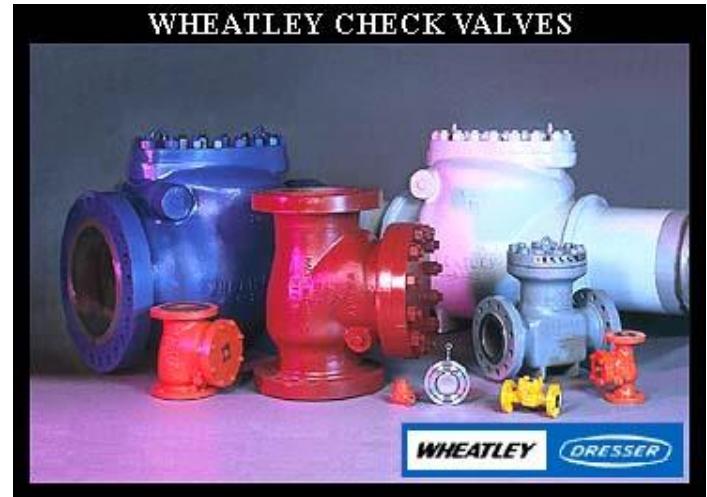
- Multi-turn valve that uses a wedge or tapered plug to control flow.
- Full port valve.
- The wedge is raised or lowered onto or off of the seat, similar to a gate valve.
- Gas flow goes straight through the valve.



# Check Valves



- Neither  $\frac{1}{4}$  turn or multi-turn valves.
- Simply swing open or closed to allow flow in one direction only.
- Flow holds the valve open. If the flow tries to reverse direction, it forces the valve closed.
- Types include: swing, lift, and ball check valves.
- Found mostly at metering or city gate stations.



# Regulators



# What is a Regulator?



- A regulator is a valve that reduces the input pressure of a fluid or gas to a desired value at its output.
- Regulator types commonly used in gas pressure reduction include:
  - Self Operated
  - Pilot Operated
  - Ball Valve

# Regulator Types – Self Operated

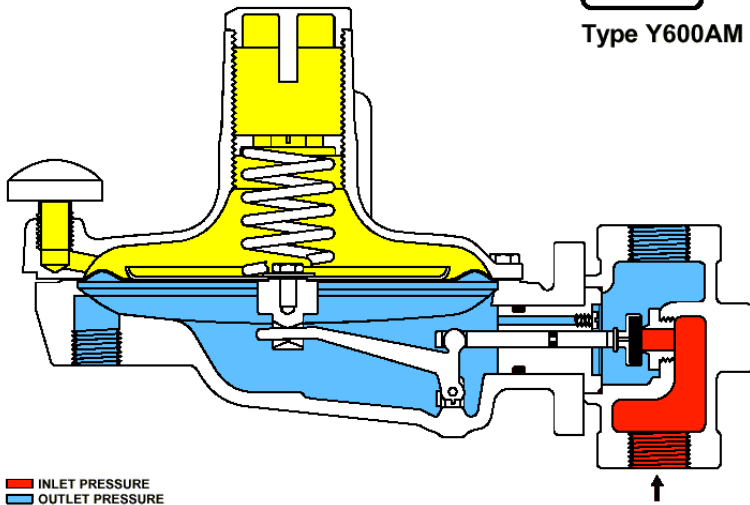


- Self-Operated regulators apply the measured pressure force directly to the loading element without an intermediate device (pilot).
- Simple design, needs only one control line connection or can measure outlet pressure internally.
- Loading element will always try to open the regulator.
- Typically utilized in relatively small volume district regulator stations (1/2" – 2") and low flows.

# Regulator Types – Self Operated

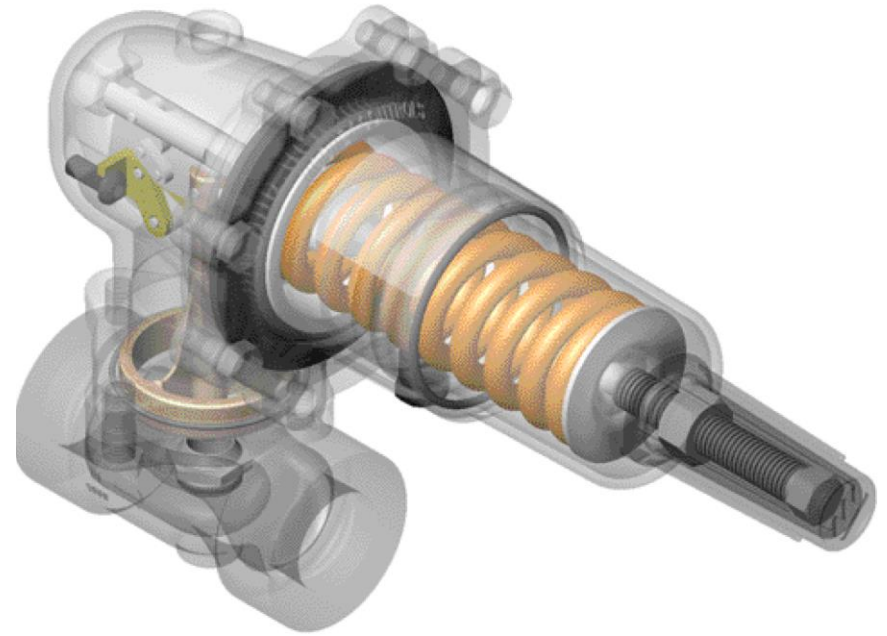


**FISHER**  
Type Y600AM



■ INLET PRESSURE  
■ OUTLET PRESSURE  
■ ATMOSPHERIC PRESSURE

82024





# Regulator Types – Pilot Operated

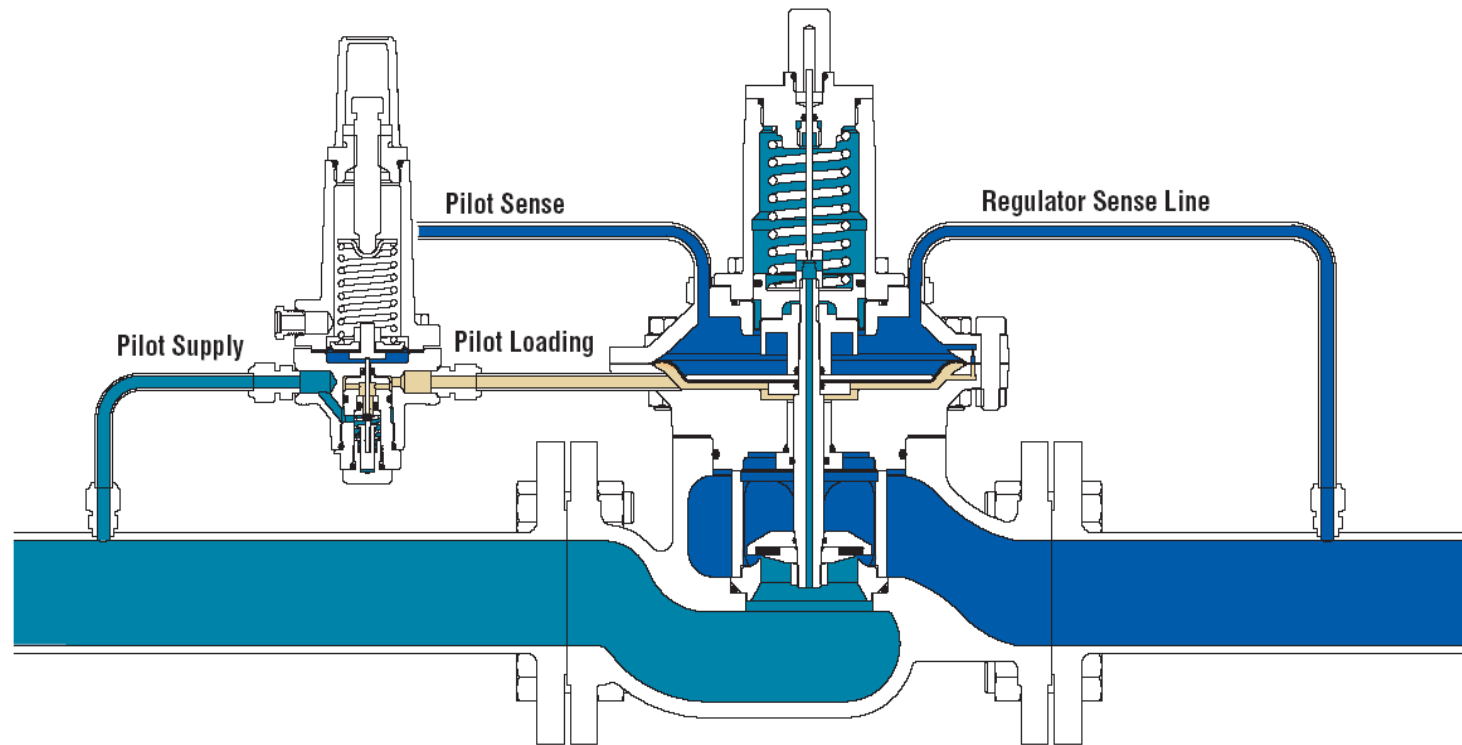


- A pilot operated regulator utilizes a pilot which senses the measured pressure. The pilot amplifies the change in the measured pressure into a larger change in the loading pressure in order to operate the restricting element.
- A pilot is a small, highly accurate self operating regulator.

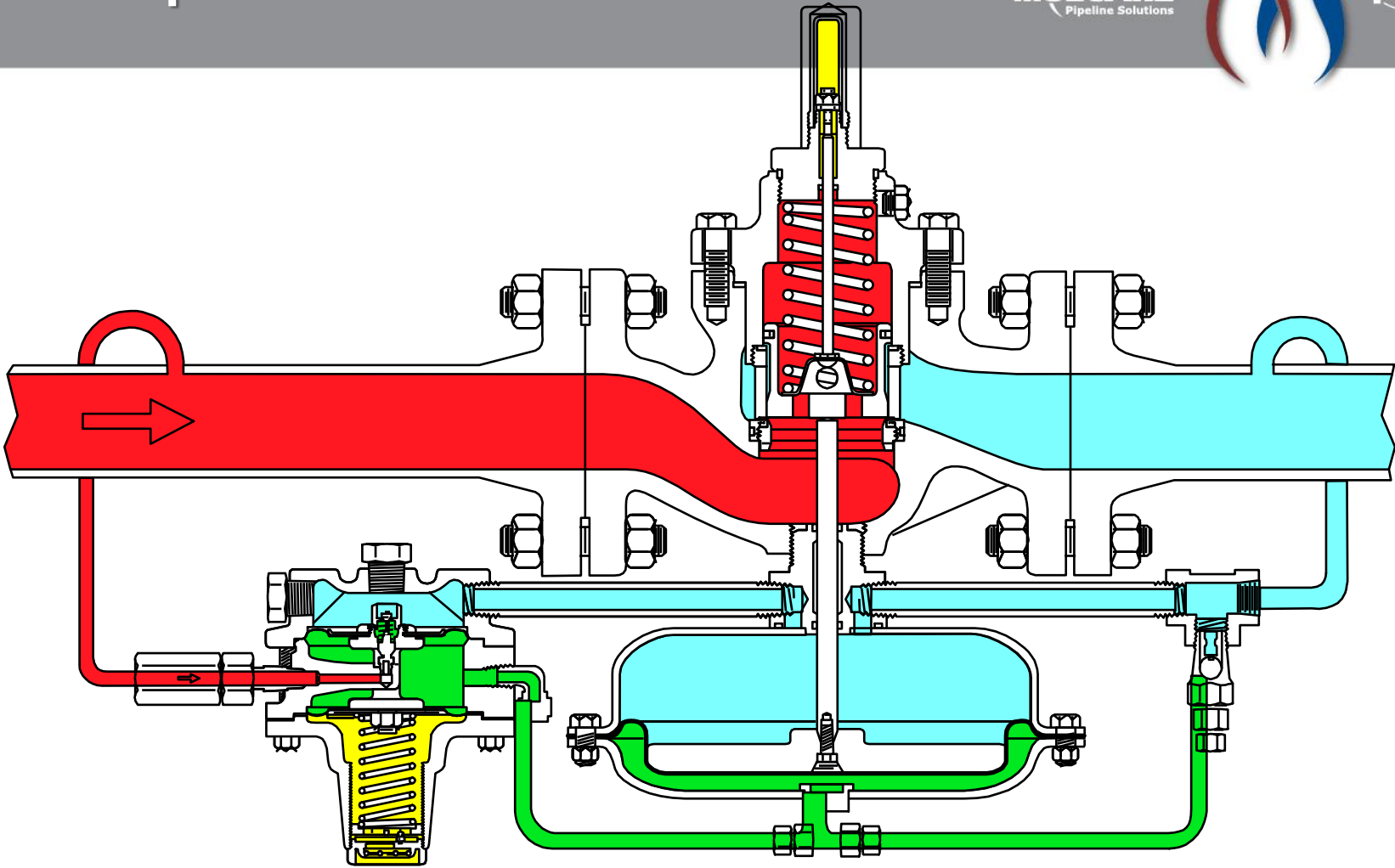


- Three types of pilot operated regulators.
  - (1) Loading (to open)
  - (2) Unloading (to open)
  - (3) Ball valve regulators (spring open, closed, last position).
- More accurate control of set point and higher capacities than self operating regulators. Can also consist of a control valve with a controller or pilot.

# Load to Open – Mooney Flowmax



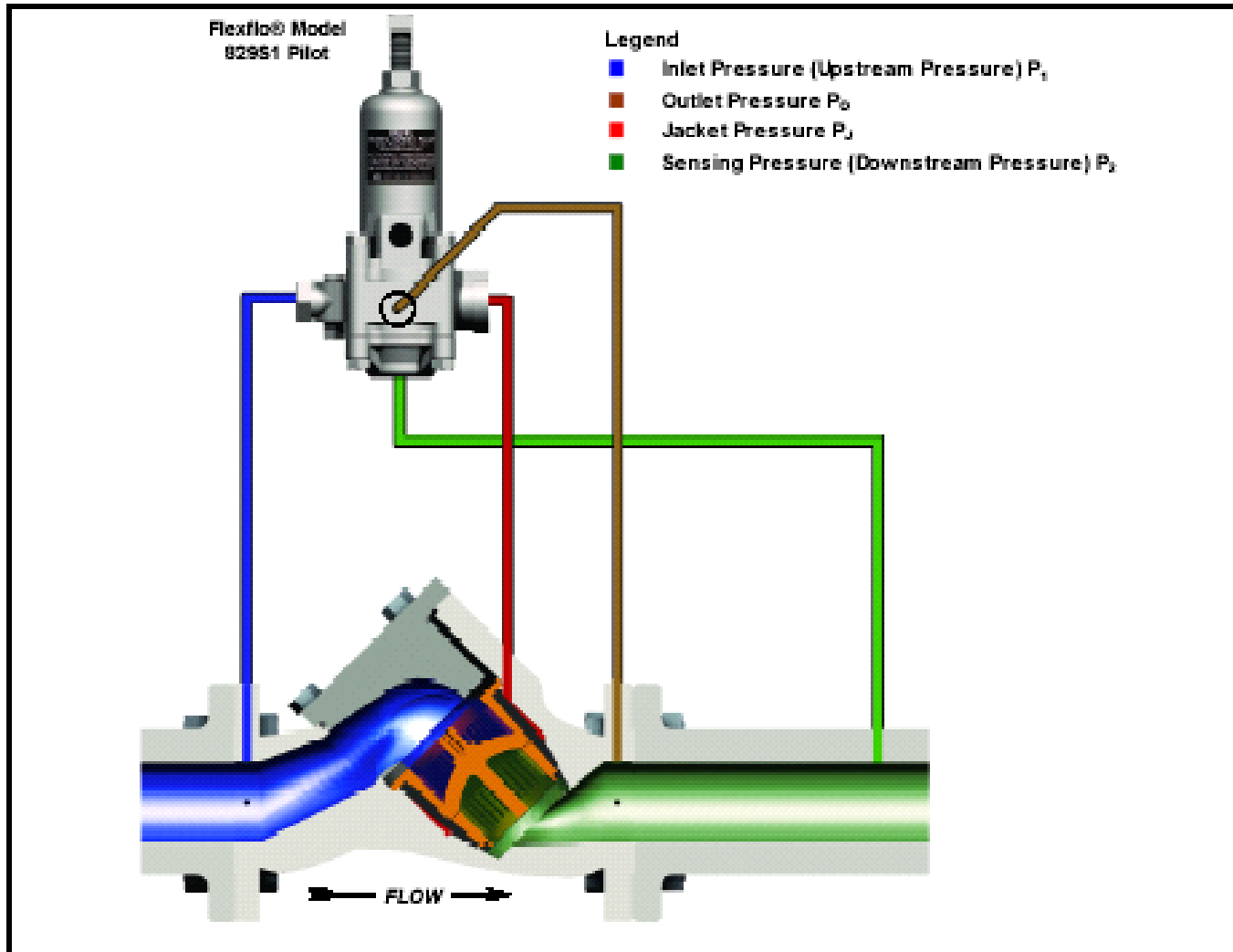
# Load to Open – Fisher 1098



- INLET PRESSURE**
- OUTLET PRESSURE**
- LOADING PRESSURE**
- ATMOSPHERIC PRESSURE**

A6563

# Unload to Open – Mooney 900 TE



# Double Acting – Ball Valve Regulator



# Over Pressure protection



- Relief Valve
- Slam Shut Valve
- Monitor Regulator

# Relief Valve



- Located downstream of a regulator facility.
- Blows gas to the atmosphere instead of over-pressurizing the system.
- Monitors pressure upstream.
- Indication of blowing relief valve is pressure rising, then going down quickly, then rising again.





# Slam Shut Valve



- Located downstream of a regulator station.
- Monitors downstream pressure.
- Slams shut if downstream pressure increases above set pressure.
- Must be manually reset.
- Indication of a slam shut being tripped is the outlet pressures rises quickly then flow stops.

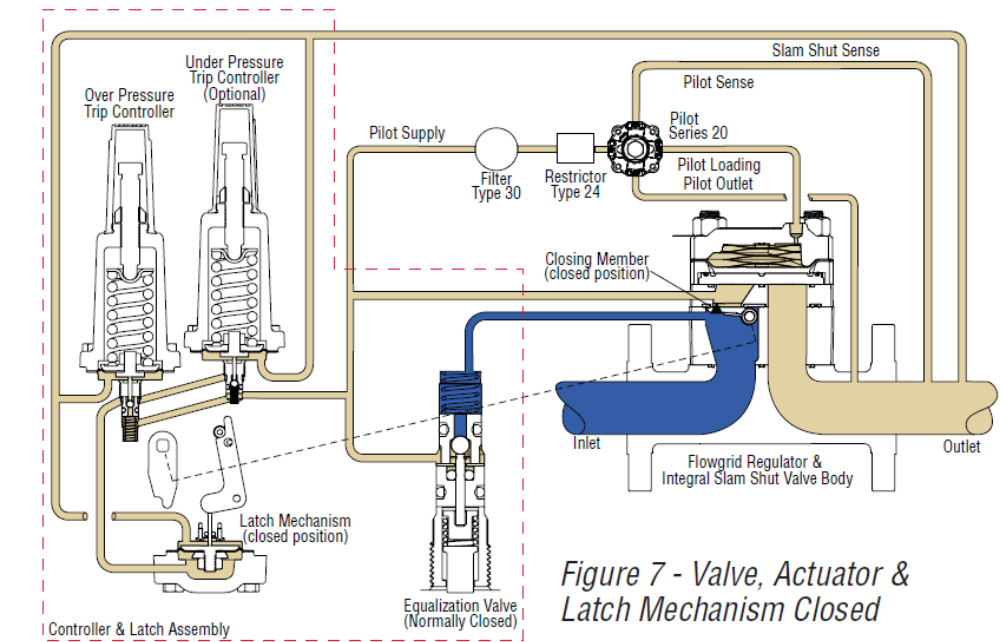
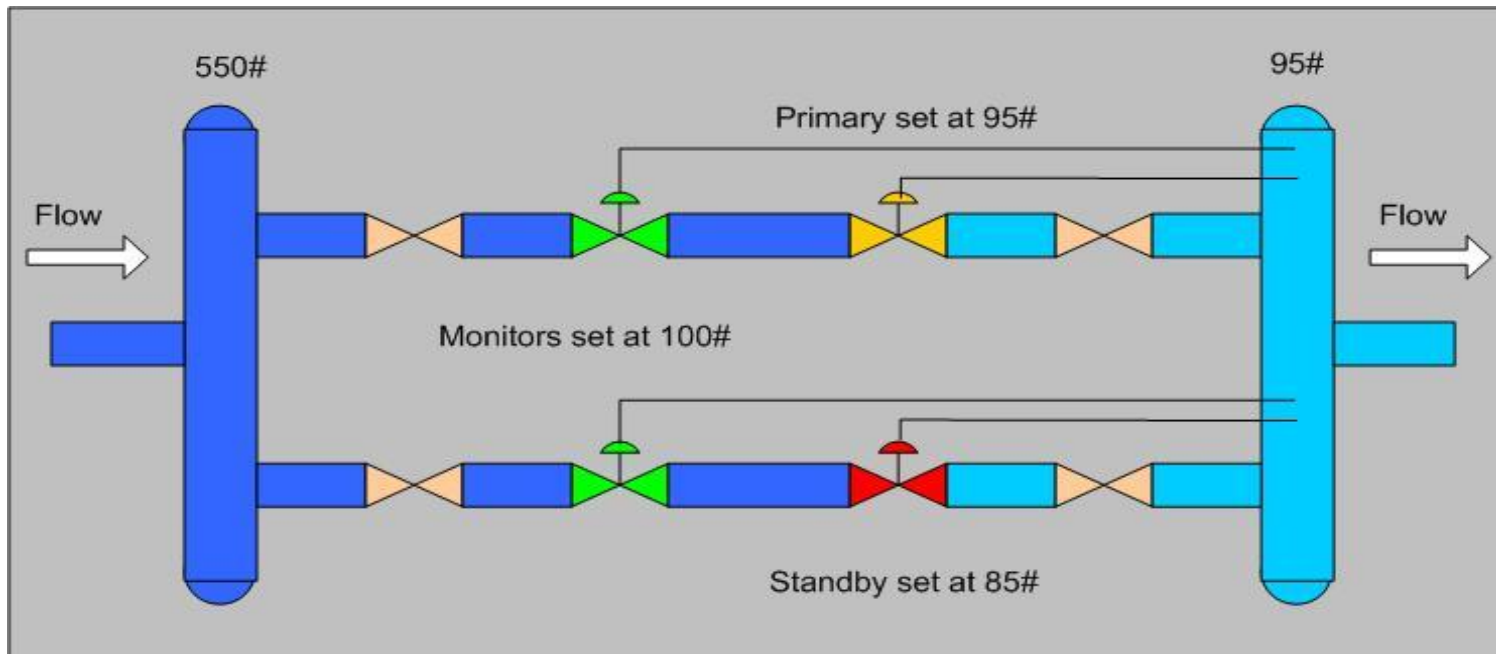


Figure 7 - Valve, Actuator & Latch Mechanism Closed

# Monitor Regulator



- Can be upstream or downstream of control regulator.
- Set at a higher pressure than the control regulator.
- Will take control when pressure reaches monitor set point.
- Setting monitor pressure to close to controller setting will cause cycling.

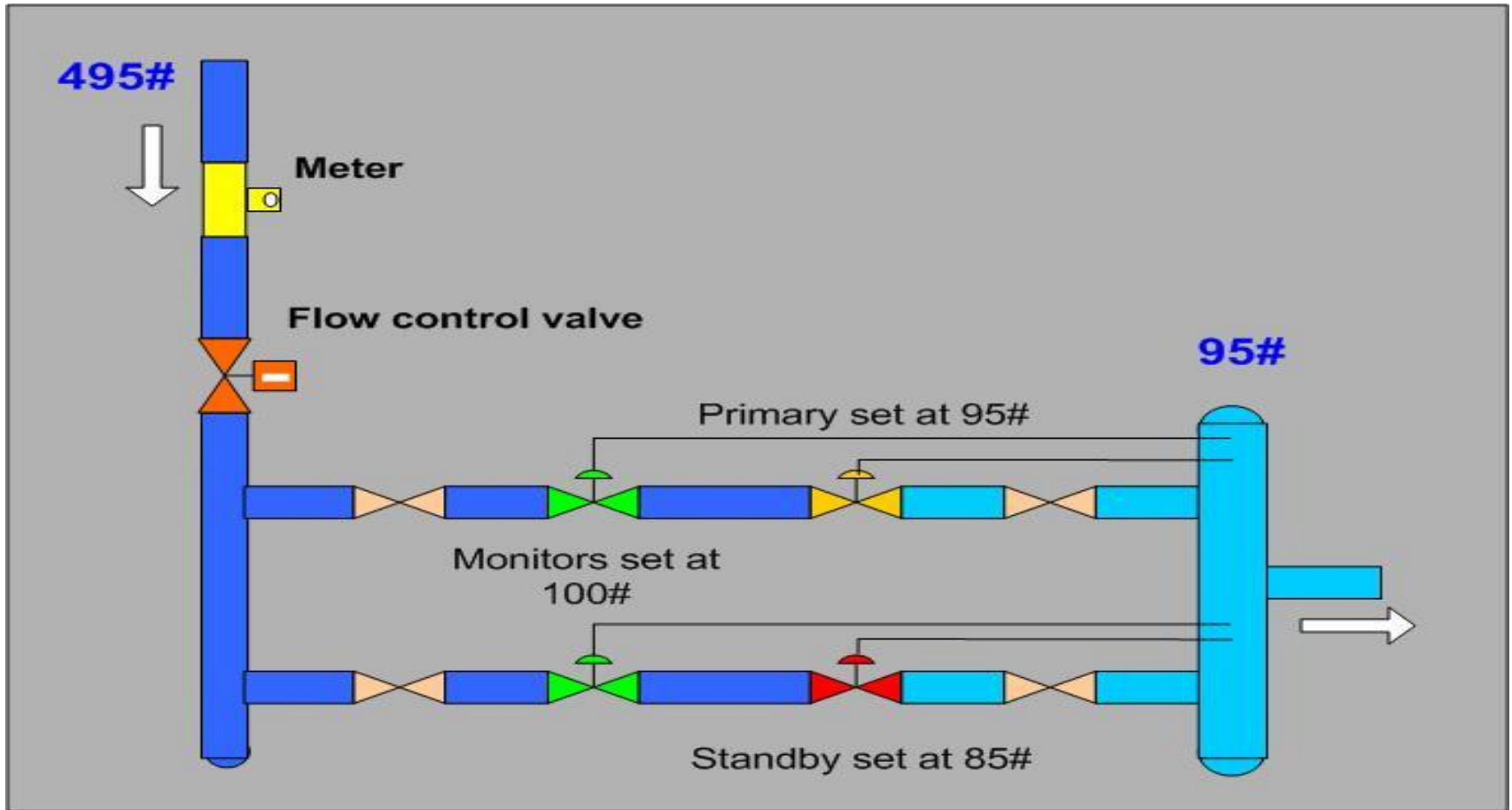




## Maximum pressure settings (49 CFR 192.201)

- MAOP 60 PSIG or greater: MAOP + 10% or the pressure that produces a hoop stress of 75% SMYS, whichever is lower
- MAOP >12 PSIG but <60 PSIG: MAOP + 6 PSIG
- MAOP < 12 PSIG: MAOP + 50%

# Flow vs. Pressure Control

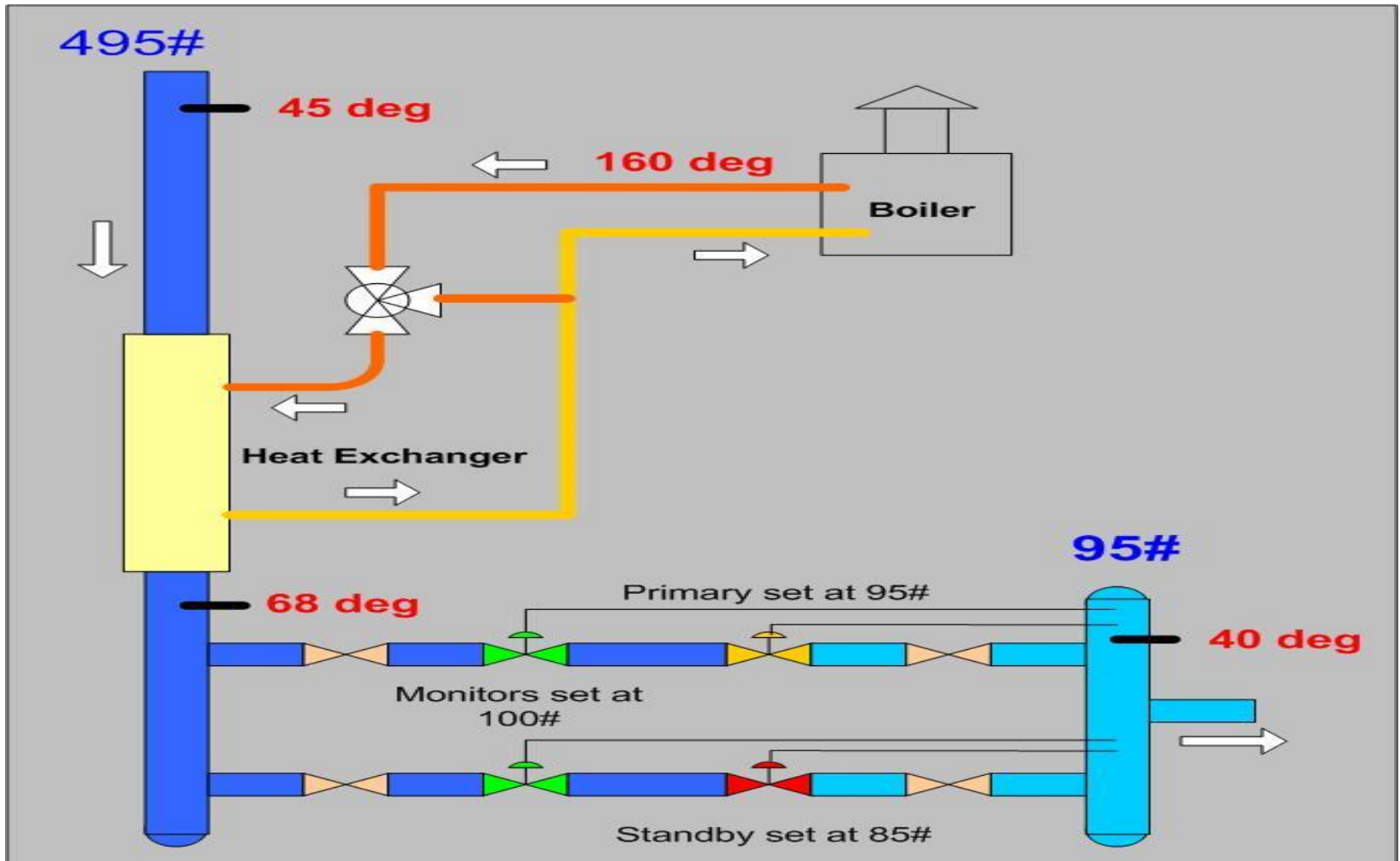


# Gas Heating Principles



- Large pressure reductions at gate stations require gas to be heated.
- “Cold Gas” can potentially cause freezing of regulator systems and other underground systems (I.E. water, steam).
- 7 degrees of temperature loss for every 100 pounds of pressure cut.

# Gate Station Gas Heating System



# Indirect Heating System



## Staged boilers



## Heat Exchanger



# Direct Heating System



## Water bath

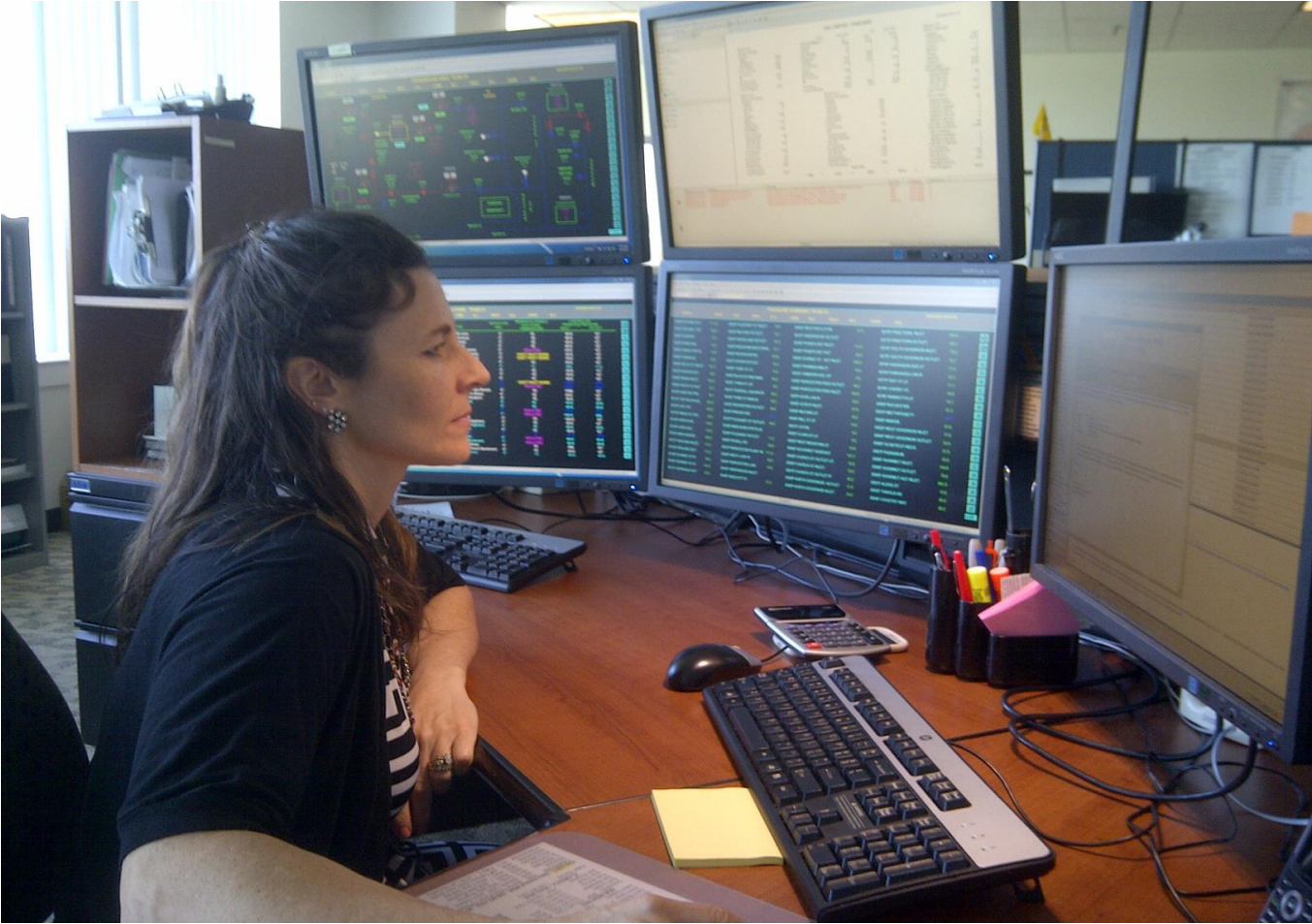


## Vacuum steam





# Gas System Remote Monitoring & Control

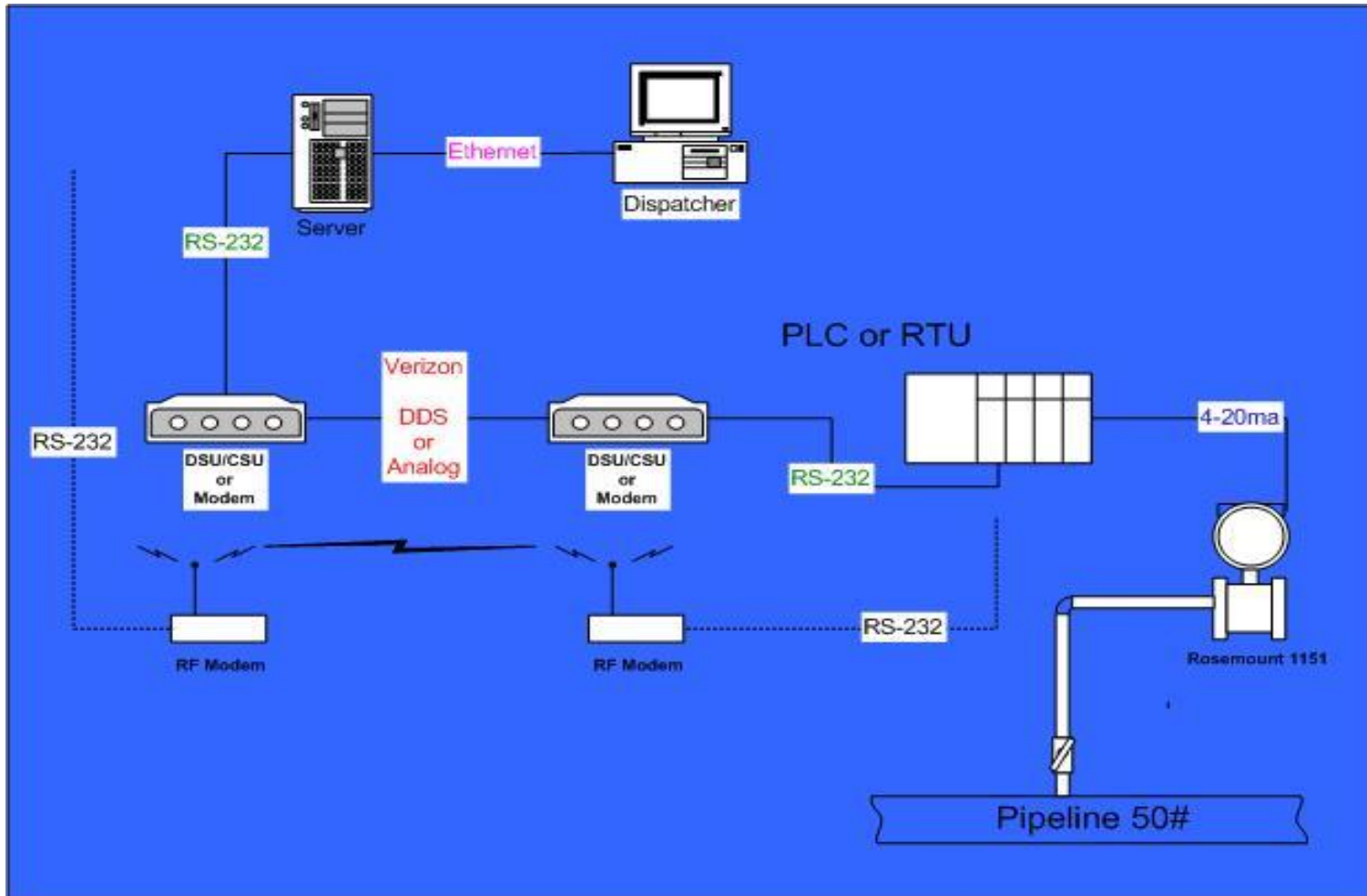


# Supervisory Control And Data Acquisition - SCADA

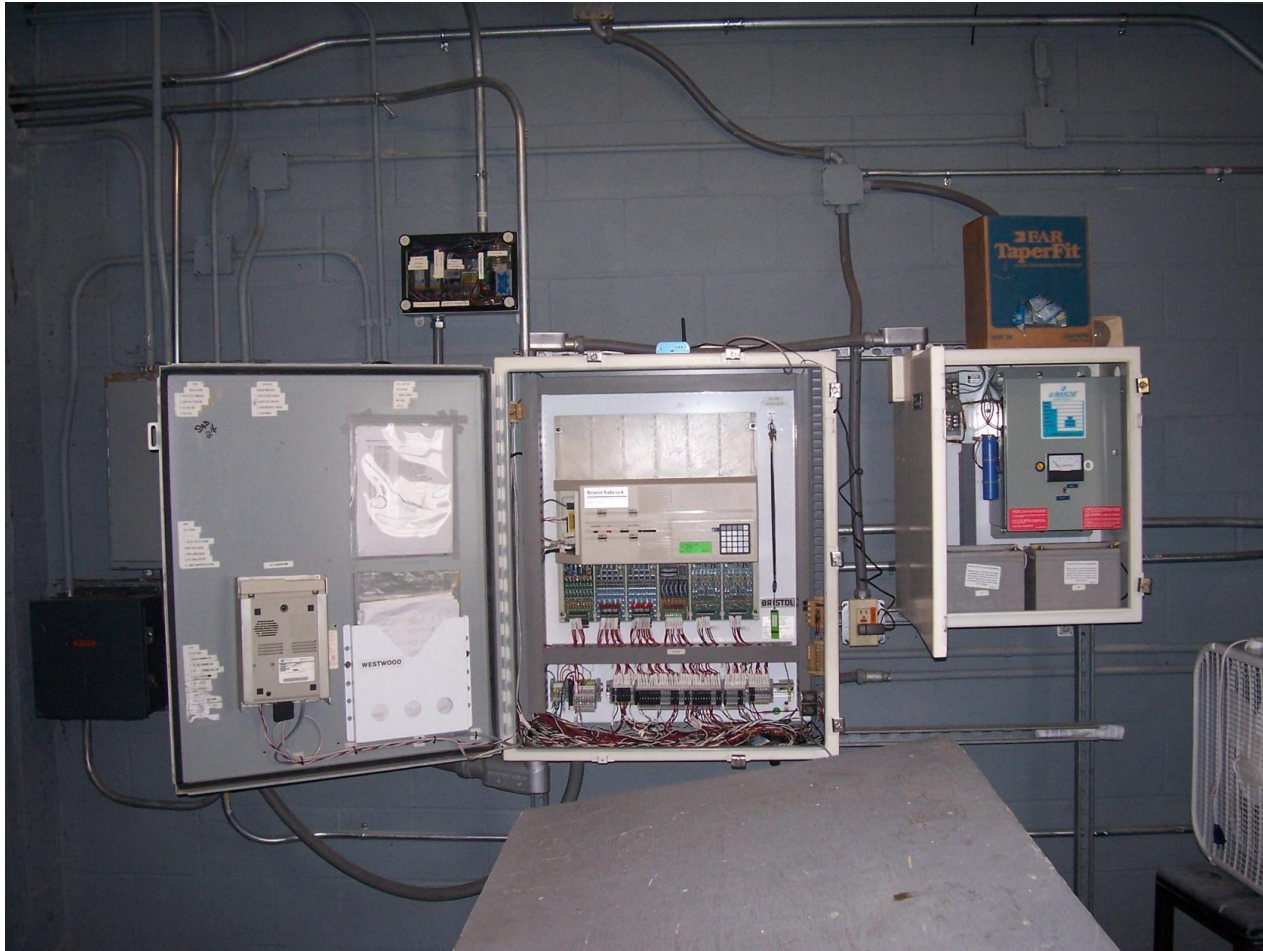


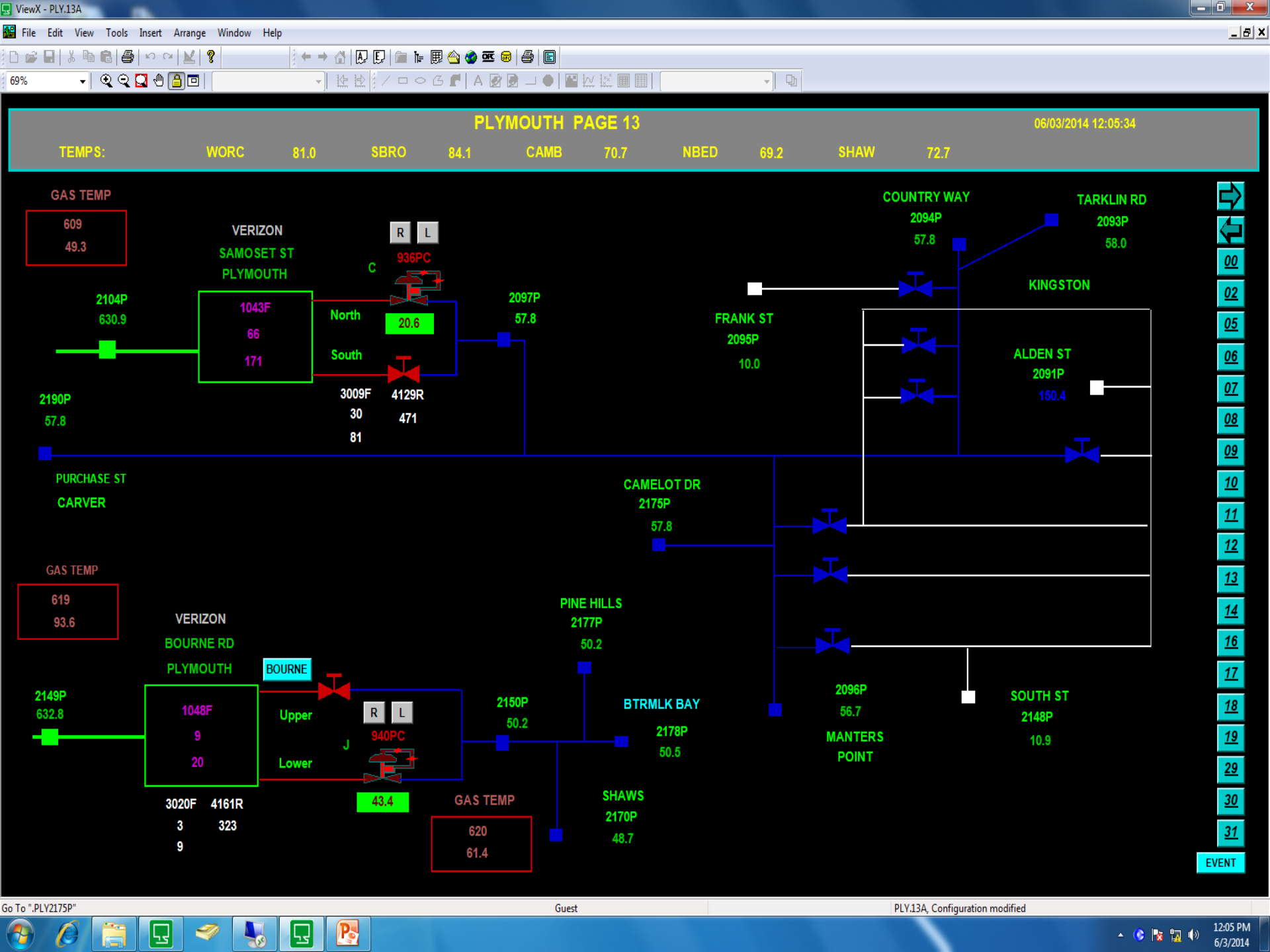
- 24x7 remote control and monitoring of the gas system.
- Safety and security of gate stations and district regulators.
- Emergency shut down of sections of the gas system.
- Balancing of gas pipeline nominations.

# Basic SCADA System Operation



# Remote Transmitting Unit (RTU)





PLYMOUTH PAGE 13

06/03/2014 12:05:34

TEMPS: WORC 81.0 SBRO 84.1 CAMB 70.7 NBED 69.2 SHAW 72.7

GAS TEMP

609  
49.3

VERIZON  
SAMOSET ST  
PLYMOUTH

1043F  
66  
171

936PC  
20.6  
3009F 4129R  
30 471  
81

2104P  
630.9

2190P  
57.8

PURCHASE ST  
CARVER

GAS TEMP

619  
93.6

VERIZON  
BOURNE RD  
PLYMOUTH

1048F  
9  
20  
3020F 4161R  
3 323  
9

BOURNE  
Upper  
Lower  
940PC  
43.4

GAS TEMP  
620  
61.4

2149P  
632.8

2150P  
50.2

PINE HILLS  
2177P  
50.2

BTRMLK BAY  
2178P  
50.5

SHAWS  
2170P  
48.7

COUNTRY WAY  
2094P  
57.8

TARKLIN RD  
2093P  
58.0

FRANK ST  
2095P  
10.0

KINGSTON

ALDEN ST  
2091P  
150.4

CAMELOT DR  
2175P  
57.8

2096P  
56.7  
MANTERS  
POINT

SOUTH ST  
2148P  
10.9



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EVENT



STATUS ALARMS PAGE 18

06/03/2014 12:10:10

TEMPS: WORC 81.6 SBRO 83.9 CAMB 71.8 NBED 70.0 SHAW 72.6

<u>MARLBORO</u>		<u>MIT</u>		<u>PLYMOUTH</u>		<u>SHAWMUT</u>	
137	AC NORMAL	134	AC NORMAL	644	MANTERS PDM	476	AC NORMAL
457	INST DOOR 1			645	SOUTH ST PDM	431	INTRUSION
461	INST DOOR 2		<u>MYSTIC</u>	646	TARKLIN PDM	575	GD LOW
458	BLR RM DOOR 1	472	AC NORMAL	1043	AGT SIG NORMAL	576	GD HIGH
462	BLR RM DOOR 2	594	GD HIGH	999	SPARE	577	GD NORMAL
459	ODR RM DOOR 1	595	GD LOW		<u>ROUTE 9</u>	668	FLTR LEV 90ULL
463	ODR RM DOOR 2	596	GD NORMAL			669	FLTR LEV 55ULL
460	REG RM DOOR 1	441	DOOR CLOSED	138	AC NORMAL	670	FLTR FILL NORM
464	REG RM DOOR 2	359	ODOR NORMAL	417	DACC DOOR 1	340	GENERATOR OFF 1
5093	.16 GAS LEL DACC RM	1050	AGT SIG NORMAL	418	DACC DOOR 2	302	ODOR NORMAL
5094	.51 GAS LEL BLR RM		<u>NORTH GOVERNOR</u>	426	BOILER DOOR 1	628	FAIRHAVEN PDM
5095	.59 GAS LEL ODOR RM			427	BOILER DOOR 2	629	MARION PDM
5096	.51 GAS LEL REG RM	373	AC NORMAL	433	REG RM DOOR 1	630	SCNTCT NECK PDM
466	BOILER 1 OFF	334	DOOR CLOSED	434	REG RM DOOR 2	1047	AGT SIGNAL
467	BOILER 2 OFF	605	CLARA PDM	5080	.75 GAS LEL DACC RM		<u>TENNESSEE</u>
348	GENERATOR NORMAL	813	HOLLY IN NORMAL	5081	.11 GAS LEL BOILER RM		
346	GENERATOR OFF 1	814	HOLLY OUT NORMAL	5082	7.01 GAS LEL REG RM 1	475	AC NORMAL
374	ODOR NORMAL	815	NGV BR NORMAL	5083	6.50 GAS LEL REG RM 2		<u>THIRD ST</u>
999	SPARE		<u>PLYMOUTH</u>	436	BOILER 1 OFF		
		478	AC NORMAL	437	BOILER 2 OFF	474	AC NORMAL
	<u>MILFORD</u>	443	DOOR CLOSED	349	GENERATOR NORMAL	311	GENERATOR OFF 1
481	AC NORMAL	506	GD NORMAL	350	GENERATOR OFF 1	445	DOOR CLOSED
336	BOILER NORMAL	597	GD LOW	611	EDGELL RD PDM	545	GD LOW REG
307	BLR WRNING	598	GD HIGH	999	SPARE	546	GD HIGH
415	REG RM DOOR	312	GENERATOR OFF 1		<u>RT 122 - WORC FEED</u>	547	GD LOW COMP
538	GD LOW	351	ODOR NORMAL	477	AC NORMAL	548	GD NORMAL
564	GD HIGH	639	ALDEN PDM	425	INTRUSION	975	KENDALL VLV OPEN
541	GD NORMAL	640	CMLLOT PDM	627	S QUIN PDM	323	GENERATOR NORMAL
449	INST RM DOOR	641	CARVER PDM	5097	.48 GAS DET LEL	976	BIOGEN VLV OPEN
360	ODOR NORMAL	642	CNTRY WAY PDM	999	SPARE	663	ALBANY PDM
1019	AGT SIG NORMAL	643	FRANK PDM	999	SPARE	664	LINWOOD PDM
						999	SPARE

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**FLOW SUMMARY PAGE 02**

06/03/2014 11:56:59

TEMPS: WORC 81.1 SBRO 83.7 CAMB 71.8 NBED 69.2 SHAW 72.4

UPLAND ST	1001	684	LNG BHL TGP	1007	0	BLACKSTONE	1053	51	ASHLAND	1015	79
		1,314			0			97			171
FARNUMSVL	1003	54	LNG TO 85	1009	0	KENDALL	1049	1,832	WESTWOOD	1016	152
		117			0			3,421			343
HUDSON	1005	144	LNG TO ASH	1011	0	M.I.T.	1041	322	HOPEDALE	1017	78
		284			0			620			156
HOPKINTON	1044	1,200	LNG TO AGT	1013	0	ENRON	1004	1,215	MILFORD	1019	0
		2,418			0			2,373			0
MARLBORO	1051	46	A/P B/O	1014	22	DISTRIGAS	1029	0	WOODLAND	1020	0
		81			48			0			0
ROUTE9	1054	0	A/P LIQ	1006	629	ASSONET	1052	25	DOVER	1021	1
		0			1,207			44			0
TGP STA TOT	4102	2,128	A/P LNG TOT	4111	0	ACUSH B/O	1040	37	MYSTIC	1050	2,546
		4,214			0			61			4,858
TGP TO 85	1008	449	UMASS MED	4401	136	ACUSH LNG	1039	0	BROOKFORD	1027	51
		914			267			0			115
TGP TO ASH	1010	123				NB & PLY	4109	536	BOURNE RD	1048	9
		232						1,147			18
P-3 TRNSFER	1028	0				FRAM TER	4107	460	FREETOWN	1042	129
		0						957			277
TGP TER TOT	4113	1,372				CAMB TER	4108	2,597	SHAWMUT	1047	271
		2,773						4,973			586
MARATHON	1013	0				AGT TER TOT	4110	2,961	SAMOSET	1043	66
		0						7,063			161
WORC LOW	1031	105							CHARLES RVR	1070	3
		205									6
ENDICOTT	1030	0							MARATHON	1012	1
		0									1
WORC FEED	1034	184							AGT STA TOT	4103	3,412
		367									6,693

**PROJECTED IMBALANCE**

TGP 6,645

AGT -7,093

CGSCHED THROUGHPUT

+/- RATE	-184	+/- RATE	-872
RATE TO GO	1,943	RATE TO GO	2,540
AMT TO GO	42,883	AMT TO GO	56,053
TGP D.C.Q.	47,094	AGT D.C.Q.	62,734

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# Abnormal Operating Conditions (AOCs)







- Pressure does not remain constant (cycling).
  - Relief valve blowing or monitor and controller regulators set too close together.
- Pressure goes higher than controller set point.
  - Failed control regulator.
- Pressure goes down to secondary run setting or line pressure drops at single run facility.
  - Possible broken main.

# Recognizing/Responding to Increased Flow Rate



- Flow rate increases and pressure decreases.
  - Possible line break.
- Flow rate and pressure increase to monitor setting.
  - Control regulator failure.

# Recognizing Active Overpressure Protection Devices



- Pressure cycles above and below relief valve setting.
  - Relief valve has been activated.
- Pressures rises above relief set point then gas flow stops immediately.
  - Slam shut valve has activated.

# Questions?

