Natural Gas Regulating Station

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Unitil natural gas

PROJECT SPONSOR

Unitil provides natural gas and electricity to regions of Maine, New Hampshire, and Massachusetts from its generation, transmission, and distribution to customers.

PROJECT SCOPE

The Ocean Road Station redesign project encompasses a comprehensive overhaul of the existing legacy metering and regulation station located in Greenland, NH. The project aims to address critical issues such as significant icing due to the Joule–Thomson effect, lack of tertiary and quaternary over-pressure protection, nearing full capacity of existing components, security concerns, among other issues.

STATION REQUIREMENTS

- Filter / Strainer
- Over pressure protection (OPP)
- Bypass methods at every step
- Heater
- HP Rotary Meter
- Super Monitor
- SCADA
- Automated Fire Valve

DESIGN PARAMETERS

PARAMETER	VALUE
MAOP	492 PSIG
Maximum flow rate (20% growth)	210 MSCFH
Maximum design velocity	80 FPS
Maximum percentage of pipe yield strength	20% SMYS

EQUATIONS

$$Q = \left[C \cdot \frac{T_b}{P_b} \left(\frac{1}{f}\right)^{0.5} \left(\frac{P_1^2 - P_2^2}{G \cdot T_f \cdot L \cdot Z}\right)^{0.5} D^{2.5} \right] \cdot E$$

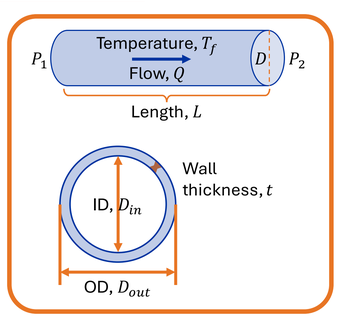
General Flow Equation

$$v = 0.05093 \frac{Q \cdot P_b \cdot T_{avg}}{(P_{avg} + P_b) \cdot T_{in} \cdot D^2}$$

Pipe Velocity Equation (FPS)

$$Q_{preheat} = Q \cdot \rho \cdot C_p \cdot \overbrace{\left(\frac{P_{in} - P_{out}}{P_{atm}} + T_{out} - T_{in}\right)}^{\Delta T_{PR}} \underbrace{\left(1 + \left(1 - \frac{\eta}{100}\right)\right)}_{\Delta T_{HE}}$$

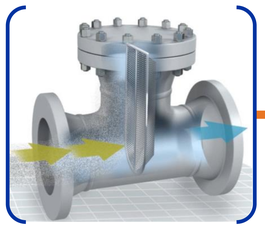
Amount of "output" (BTU/hr.) required from heater



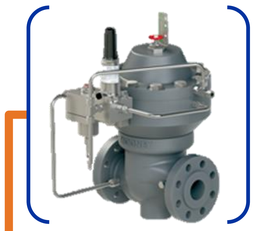
OBJECTIVE

Ensure safe and reliable delivery of natural gas to existing customers while incorporating industry best practices and modern redundant safety features.

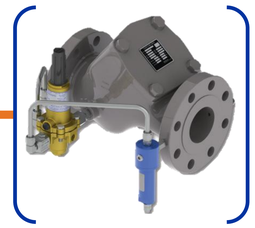
TERI Vertical Indirect-Fired Water Bath Heaters



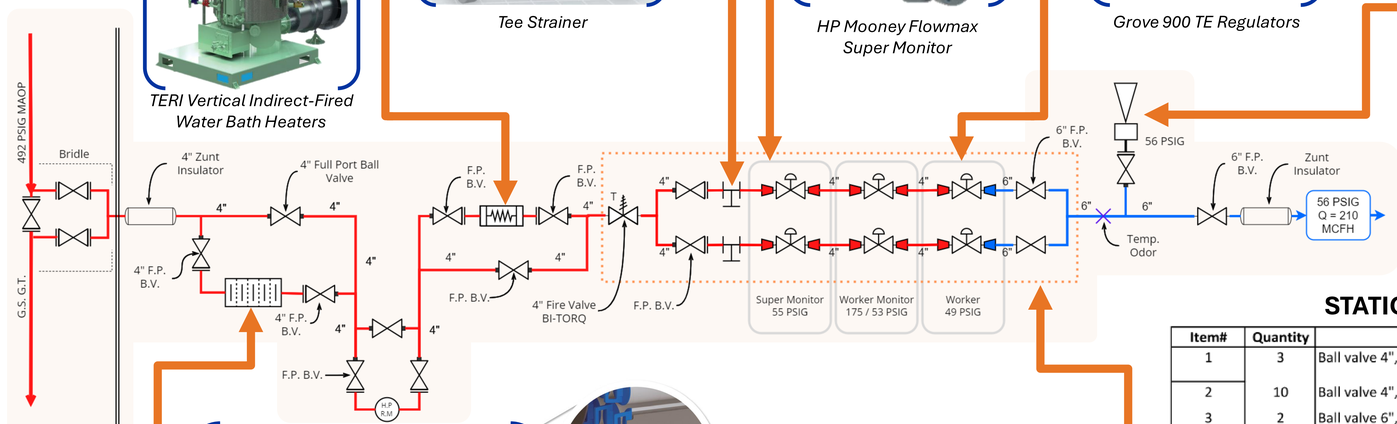
Tee Strainer

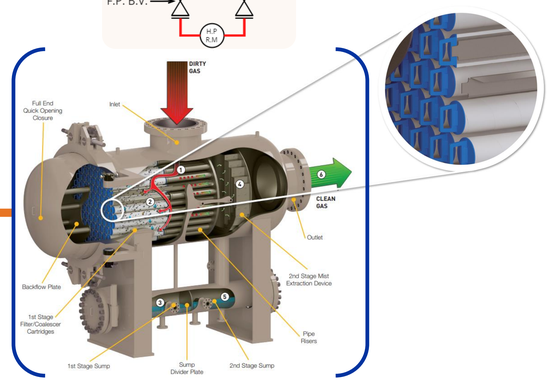


HP Mooney Flowmax Super Monitor



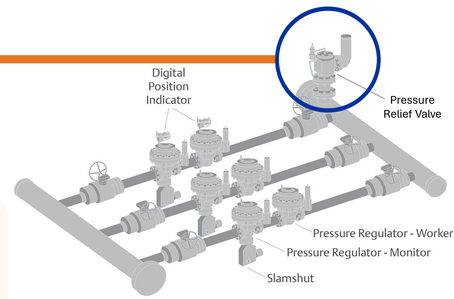
Grove 900 TE Regulators





PECO Filter-Separator

Building



Regulator Runs with Pressure Relief Valve

THE STATION'S FUTURE

- Project Kickoff
- Final Approvals
- Design Phase
- Cost Estimating
- Engineering Contractor Deliverables
- Permitting Phase
- Construction Phase
- As Built Phase
- Documentation Phase
- Maintenance and Longevity

STATION COMPONENTS AND COSTS

Item#	Quantity	Description	Unit Price	Total
1	3	Ball valve 4", Class 300, WE x WE lever operated.	$2,500.00	$7,500.00
2	10	Ball valve 4", Class 300, WE x RF lever operated.	$2,500.00	$25,000.00
3	2	Ball valve 6", Class 300, WE x RF gear operated.	$6,400.00	$12,800.00
4	1	Ball valve 6", Class 150, WE x WE buried lever operated.	$6,100.00	$6,100.00
5	2	HP flowmax 2", class 300	$11,500.00	$23,000.00
6	4	Grove 900TE, 2", class 300	$6,400.00	$25,600.00
7	2	Tee strainer 4"	$2,200.00	$4,400.00
8	1	Vertical OGI teri heater	$170,000.00	$170,000.00
9	1	HP rotary meter 11M740CD with corrector	$23,593.00	$23,593.00
10	1	Peco Filter separator 4" RFxRF	$8,505.00	$8,505.00
11	1	Inlet zunt insulating joint	$1,155.00	$1,155.00
12	1	Outlet zunt insulating joint	$1,309.00	$1,309.00
13	1	Ball valve 4" class 300 RFx RF w/ Bitork actuator fire valve	$12,210.00	$12,210.00
14	1	Relief valve - Mercer	$14,123.00	$14,123.00
~~15~~	~~1~~	~~Rupture disc & holder~~	~~$5,852.00~~	~~$5,852.00~~
16	2	Gas detection MSA-GM X5000 Gas Monitor	$5,537.00	$11,074.00
			Total	$352,221.00

ENVIRONMENT CONDITIONS			
T_1	Base Temperature	32	°F
T_1c	Converted base temperature	491.67	°R
P_1	Inlet pressure	492	PSIG
P_1c	Converted inlet pressure	506.73	PSIA

GAS RELATED			
Q	Flow rate (based on standard flow pressure 14.73 PSIA and 60°F)	210.00	MCFH
	Fluid	NATURAL GAS	
G	Specific gravity (common to assume 0.60 for natural gas)	0.58	
mu	Dynamic viscosity of gas	0.0000072	LBM/FT-S
T_flow	Temperature of flowing gas	60	°F
T_flowc	Converted temp of flowing gas	519.67	°R
T_avg	Average Temperature	46	°F

PIPE			
	Pipe size and type	6" STEEL - XLS -432	
D_in	INTERNAL pipe diameter	5.761	INCH
k	Roughness	0.0018	INCH
epsilon	Relative roughness	0.000312446	
	Length of Pipe	20	FEET
L	Converted length of pipe	20.00	FEET
C	Equation constant for corresponding units in sheet	117.3	
E	Pipe efficiency	1	
Z	Compressibility GPSA method	1	

OTHER			
F2RANKINE	Fahrenheit to rankine conversion	459.67	
P_b	Base pressure (standard value of 14.73 PSIA in the US)	14.73	PSIA
T_b	Base temperature (standard value is 60°F in the US, 519.67°R	491.67	°R

Example Calculation Case: 6" Steel Extra Strength

KEY
Drop down selection
Automatically populate
User-populated
Intermediate Calculated value
Secondary Calculated values
Calculated value

- Model showing pipeline velocity less than 80 FPS with environmental/initial conditions
- Shows calculated friction factors and Reynolds number

COLEBROOK-WHITE FRICTION FACTOR CALCULATION			
f_D	Darcy-Weisback Friction Factor	0.015461	
f_F	Fanning Friction Factor	0.003865	
objective	Variable used in Goal Seek to find friction factor	0.006439	
	Percent difference between LEFT and RIGHT	0.501399	%
LEFT	Colebrook-White left side of equation	8.042269	
RIGHT	Colebrook-White right side of equation	7.962023	
Re	Reynolds number for partially turbulent or full turbulent	1,008,075	Turbulent

PRESSURE/PIPELINE CALCULATIONS			
P_2	Outlet Pressure	492.00	PSIG
P_2c	Converted outlet pressure	13638.21	Inches W.C.
P_avg	Average pressure along pipe	477.3	PSIG
dP	Total change in pressure from inlet to outlet	0.00	PSID
	PIPELINE VELOCITY	9.923	ft/s

Station Classifications:

- Pipeline and Hazardous Materials Safety Administration (PHMSA), Department of Transportation (DOT) Location: **Class 4**
- National Electrical Code Hazardous Location: **Class 1, Division 1**

Terms to know:

- GSGT: *Granite State Gas Transmission*
- OPP: *Over pressure protection*
- MAOP: *Maximum allowable operating pressure*
- SMYS: *Specified minimum yield strength*
- CFR: *Code of federal regulations*
- PSIG: *Pounds per square inch gauge (unit of pressure)*
- BTU: *British thermal units (measure of heat)*
- SCADA: *Supervisory control and data acquisition*