

CAPACITY CALCULATIONS FOR STEAM LOADS

When BTU Load is Known	Capacity of steam required (lbs/hr)	=	$\frac{\text{BTU}}{1000}$
When Square Feet Equivalent Direct Radiation (EDR) is Known	Capacity of steam required (lbs/hr)	=	$\frac{\text{Sq ft. of EDR}}{4}$
When Heating Water with Steam	Capacity of steam required (lbs/hr)	=	$\frac{\text{GPM} \times \text{Temp Rise } ^\circ\text{F}}{2}$
When Heating Fuel Oil with Steam	Capacity of steam required (lbs/hr)	=	$\frac{\text{GPM} \times \text{Temp Rise } ^\circ\text{F}}{4}$
When Heating Air with Steam Coils	Capacity of steam required (lbs/hr)	=	$\frac{\text{CFM} \times \text{Temp Rise } ^\circ\text{F}}{900}$

HEATING AIR WITH STEAM PIPE COILS

$$\text{Steam lbs/hr} = \frac{A \times U \times (\Delta) T}{L}$$

A = Area of heating surface in sq. ft.

U = Heat transfer coefficient
(2 for free convection)

(Δ) T = Steam Temperature – Air Temperature in $^\circ\text{F}$

L = Latent heat of Steam BTU / lb

STEAM TRAP SIZING AND SELECTION

Drip Trap on Steam Mains: Should be sized for 2X safety factor at full differential pressure

Primary choice for trap: 1/2" WD600L Thermodynamic
3/4" WD600L Thermodynamic

Place trap every 200 ft. depending on type size, pressure, and piping configuration.

Steam Tracing:

Typically a trap is placed approximately every 100 ft.

Primary choice for trap: 1/2" WT2000 Thermostatic
1/2" WT1000 Thermostatic

Bucket traps and thermodynamic traps are used on critical tracing applications where no condensate can back-up.

Process Applications:

2X safety factor based on differential pressure

When used to drain a heat exchanger being supplied by a modulating control valve using less than 30 PSIG steam pressure, trap must handle full load at 1/2 PSI differential pressure.

When used to drain a heat exchanger being supplied by a modulating control valve using with steam pressure greater than 30 PSIG use 2.5X safety factor at full differential pressure.

Primary choice for trap: Float & Thermostatic

Properties of Saturated Steam

Pressure	Temp. (°F)	Heat (BTU/lb)			Volume (ft ³ /lb)		Pressure (psig)	Temp. (°F)	Heat (BTU/lb)			Volume (ft ³ /lb)		
		Sensible	Latent	Total	Cond	Steam			Sensible	Latent	Total	Cond	Steam	
(Hg vac)														
25	133	101	1018	1119	0.01626	143.3	150	366	339	857	1196	0.01818	2.756	
20	161	129	1002	1131	0.01640	75.41	155	368	341	855	1196	0.01821	2.678	
15	179	147	991	1138	0.01650	51.41	160	371	344	853	1196	0.01824	2.605	
10	192	160	983	1143	0.01659	39.22	165	373	346	851	1197	0.01827	2.535	
5	203	171	976	1147	0.01666	31.82	170	375	349	849	1197	0.01830	2.469	
(psig)							175	377	351	847	1198	0.01833	2.407	
0	212	180	970	1151	0.01672	26.80	180	380	353	845	1198	0.01835	2.347	
1	215	184	968	1152	0.01674	25.21	185	382	355	843	1198	0.01839	2.291	
2	219	187	966	1153	0.01676	23.79	190	384	358	841	1199	0.01841	2.237	
3	222	190	964	1154	0.01679	22.53	195	386	360	839	1199	0.01844	2.185	
4	224	193	962	1155	0.01681	21.40	200	388	362	837	1199	0.01847	2.136	
5	227	195	961	1156	0.01683	20.38	205	390	364	836	1200	0.01850	2.089	
6	230	198	959	1157	0.01685	19.46	210	392	366	834	1200	0.01852	2.044	
7	232	201	957	1158	0.01687	18.62	215	394	368	832	1200	0.01855	2.001	
8	235	203	956	1159	0.01689	17.85	220	395	370	830	1200	0.01857	1.960	
9	237	206	954	1160	0.01690	17.14	225	397	372	829	1201	0.01860	1.920	
10	239	208	953	1160	0.01692	16.49	230	399	374	827	1201	0.01863	1.882	
12	244	212	950	1162	0.01696	15.33	235	401	376	825	1201	0.01865	1.845	
14	248	216	947	1163	0.01699	14.33	240	403	378	823	1201	0.01868	1.810	
16	252	220	944	1165	0.01702	13.45	245	404	380	822	1202	0.01870	1.776	
18	255	224	942	1166	0.01705	12.68	250	406	382	820	1202	0.01873	1.744	
20	259	228	940	1167	0.01708	11.99	255	408	384	818	1202	0.01875	1.712	
22	262	231	937	1168	0.01711	11.38	260	409	385	817	1202	0.01878	1.682	
24	265	234	935	1169	0.01713	10.83	265	411	387	815	1202	0.01880	1.652	
25	267	236	934	1170	0.01715	10.57	270	413	389	814	1203	0.01882	1.624	
26	268	237	933	1170	0.01716	10.33	275	414	391	812	1203	0.01885	1.596	
28	271	240	931	1171	0.01719	9.874	280	416	392	811	1203	0.01887	1.570	
30	274	243	929	1172	0.01721	9.459	285	417	394	809	1203	0.01889	1.544	
32	277	246	927	1173	0.01723	9.078	290	419	396	808	1203	0.01891	1.520	
34	279	249	925	1174	0.01726	8.728	295	420	397	806	1203	0.01894	1.497	
35	281	250	924	1174	0.01727	8.563	300	422	399	805	1203	0.01896	1.473	
36	282	251	923	1174	0.01728	8.404	310	425	402	802	1204	0.01901	1.428	
38	284	254	922	1175	0.01730	8.104	320	428	405	799	1204	0.01906	1.386	
40	287	256	920	1176	0.01733	7.826	330	430	408	796	1204	0.01910	1.346	
42	289	258	918	1177	0.01735	7.566	340	433	411	793	1204	0.01915	1.309	
44	291	261	916	1177	0.01737	7.323	350	436	414	790	1204	0.01919	1.273	
45	292	262	916	1178	0.01738	7.208	360	438	417	787	1204	0.01923	1.240	
46	294	263	915	1178	0.01739	7.096	370	441	420	785	1204	0.01927	1.207	
48	296	265	913	1178	0.01741	6.883	380	443	423	782	1205	0.01932	1.177	
50	298	267	912	1179	0.01743	6.683	390	446	426	779	1205	0.01936	1.148	
55	303	272	908	1180	0.01748	6.230	400	448	428	777	1205	0.01940	1.120	
60	307	277	905	1182	0.01753	5.837	450	460	441	764	1205	0.01961	0.9992	
65	312	282	901	1183	0.01757	5.491	500	470	453	752	1205	0.01980	0.9010	
70	316	286	898	1184	0.01761	5.184	550	480	464	740	1204	0.02000	0.8195	
75	320	291	895	1185	0.01766	4.911	600	489	475	729	1203	0.02019	0.7509	
80	324	295	892	1186	0.01770	4.665	650	497	485	718	1203	0.02038	0.6922	
85	328	298	889	1187	0.01774	4.444	700	505	494	707	1202	0.02056	0.6415	
90	331	302	886	1188	0.01778	4.242	750	513	504	697	1200	0.02074	0.5971	
95	335	306	883	1189	0.01782	4.059	800	520	512	687	1199	0.02092	0.5580	
100	338	309	881	1190	0.01785	3.891	900	534	529	667	1196	0.02128	0.4922	
105	341	312	878	1190	0.01789	3.736	1000	546	545	648	1192	0.02164	0.4390	
110	344	316	876	1191	0.01792	3.594	1250	574	581	601	1182	0.02256	0.3410	
115	347	319	873	1192	0.01796	3.462	1500	598	614	556	1169	0.02352	0.2740	
120	350	322	871	1192	0.01799	3.340	1750	618	644	510	1155	0.02456	0.2248	
125	353	325	868	1193	0.01803	3.226	2000	637	674	463	1137	0.02572	0.1864	
130	356	328	866	1194	0.01806	3.119	2250	654	703	413	1116	0.02707	0.1554	
135	358	331	864	1194	0.01809	3.020	2500	669	734	358	1092	0.02871	0.1293	
140	361	333	861	1195	0.01812	2.927	2750	683	766	295	1061	0.03097	0.1062	
145	363	336	859	1195	0.01815	2.839	3000	696	805	211	1016	0.03465	0.0835	
							3194	706	906	0	906	0.05078	0.0508	

Warm Up Loads in Pounds of Steam per hour per 100 ft. of Steam Main

Outside Temperature at 70°F Based on Sch. 40 Pipe Up to 250 PSI. Sch. 80 Above 250 PSI. Sch. 120 5" & Larger Above 800 PSI															
Steam Pressure (psig)	2"	2-1/2"	3"	4"	5"	6"	8"	10"	12"	14"	16"	18"	20"	24"	°F Correction Factor†
0	6.2	9.7	12.8	18.2	24.6	31.9	48	68	90	107	140	176	207	308	1.5
5	6.9	11.0	14.4	20.4	27.7	35.9	48	77	101	120	157	198	233	324	1.44
10	7.5	11.8	15.5	22.0	29.9	38.8	58	83	109	130	169	213	251	350	1.41
20	8.4	13.4	17.5	24.9	33.8	44	66	93	124	146	191	241	284	396	1.37
40	9.9	15.8	20.6	30.3	39.7	52	78	110	145	172	225	284	334	465	1.32
60	11.0	17.5	22.9	32.6	44	57	86	122	162	192	250	316	372	518	1.29
80	12.0	19.0	24.9	35.3	48	62	93	132	175	208	271	342	403	561	1.27
100	12.8	20.3	26.6	37.8	51	67	100	142	188	222	290	366	431	600	1.26
125	13.7	21.7	28.4	40	55	71	107	152	200	238	310	391	461	642	1.25
150	14.5	23.0	30.0	43	58	75	113	160	212	251	328	414	487	679	1.24
175	15.3	24.2	31.7	45	61	79	119	169	224	265	347	437	514	716	1.23
200	16.0	25.3	33.1	47	64	83	125	177	234	277	362	456	537	748	1.22
250	17.2	27.3	35.8	51	69	89	134	191	252	299	390	492	579	807	1.21
300	25.0	38.3	51	75	104	143	217	322	443	531	682	854	1045	1182	1.20
400	27.8	43	57	83	116	159	241	358	493	590	759	971	1163	1650	1.18
500	30.2	46	62	91	126	173	262	389	535	642	825	1033	1263	1793	1.17
600	32.7	50	67	98	136	187	284	421	579	694	893	1118	1367	1939	1.16
800	38	58	77	113	203	274	455	670	943	1132	1445	1835	2227	3227	1.16
1000	45	64	86	126	227	305	508	748	1052	1263	1612	2047	2485	3601	1.15
1200	52	72	96	140	253	340	566	833	1172	1407	1796	2280	2767	4010	1.14
1400	62	79	106	155	280	376	626	922	1297	1558	1988	2524	3064	4440	1.13
1600	71	87	117	171	309	415	692	1018	1432	1720	2194	2786	3382	4901	1.13
1750	78	94	126	184	333	448	746	1098	1544	1855	2367	3006	3648	5285	1.13
1800	80	97	129	189	341	459	764	1125	1584	1902	2427	3082	3741	5420	1.13

Running Loads in Pounds of Steam per hour per 100 ft. of Steam Main

Outside Temperature at 70°F Insulation 70% Efficient.															
Steam Pressure (psig)	Pipe Size													°F Correction Factor†	
	2"	2-1/2"	3"	4"	5"	6"	8"	10"	12"	14"	16"	18"	20"		24"
10	6	7	9	11	13	16	20	24	29	32	36	39	44	53	1.58
30	8	9	11	14	17	20	26	32	38	42	48	51	57	68	1.50
60	10	12	14	18	24	27	33	41	49	54	62	67	74	89	1.45
100	12	15	18	22	28	33	41	51	61	67	77	83	93	111	1.41
125	13	16	20	24	30	36	45	56	66	73	84	90	101	121	1.39
175	16	19	23	26	33	43	53	66	78	86	98	107	119	141	1.38
250	18	22	27	34	42	50	62	77	92	101	116	126	140	168	1.36
300	20	25	30	37	46	54	68	85	101	111	126	138	154	184	1.35
400	23	28	34	43	53	63	80	99	118	130	148	162	180	216	1.33
500	27	33	39	49	61	73	91	114	135	148	170	185	206	246	1.32
600	30	37	44	55	68	82	103	128	152	167	191	208	232	277	1.31
800	36	44	53	69	85	101	131	164	194	214	244	274	305	365	1.30
1000	43	52	63	82	101	120	156	195	231	254	290	326	363	435	1.27
1200	51	62	75	97	119	142	185	230	274	301	343	386	430	515	1.26
1400	60	73	89	114	141	168	219	273	324	356	407	457	509	610	1.25
1600	69	85	103	132	163	195	253	31	375	412	470	528	588	704	1.22
1750	76	93	113	145	179	213	278	347	411	452	516	580	645	773	1.22
1800	79	96	117	150	185	221	288	358	425	467	534	600	667	800	1.21

SIZING STEAM PIPES

Saturated steam lines should be sized for a steam velocity of 4800 to 7200 ft/min.

Piping on pressure reducing stations should be sized for the same steam velocity on both sides of the regulator. This usually results in having a regulator smaller than the piping and having larger piping on the downstream side of the regulator.

Example using Steam Velocity Chart (opposite page):

- 100 PSIG Inlet Pressure to control valve
- 25 PSIG Outlet Pressure
- 1000 lbs/hr flow rate
- Determine pipe size required

Upstream Piping:

- Enter Velocity Chart at **A** 1000 lbs/hr.
- Follow line to **B** 100 PSIG Inlet Pressure
- Follow line vertically upwards to **C** 1-1/2" Pipe Diameter
- Steam Velocity at **D** shows 4800 ft./min.

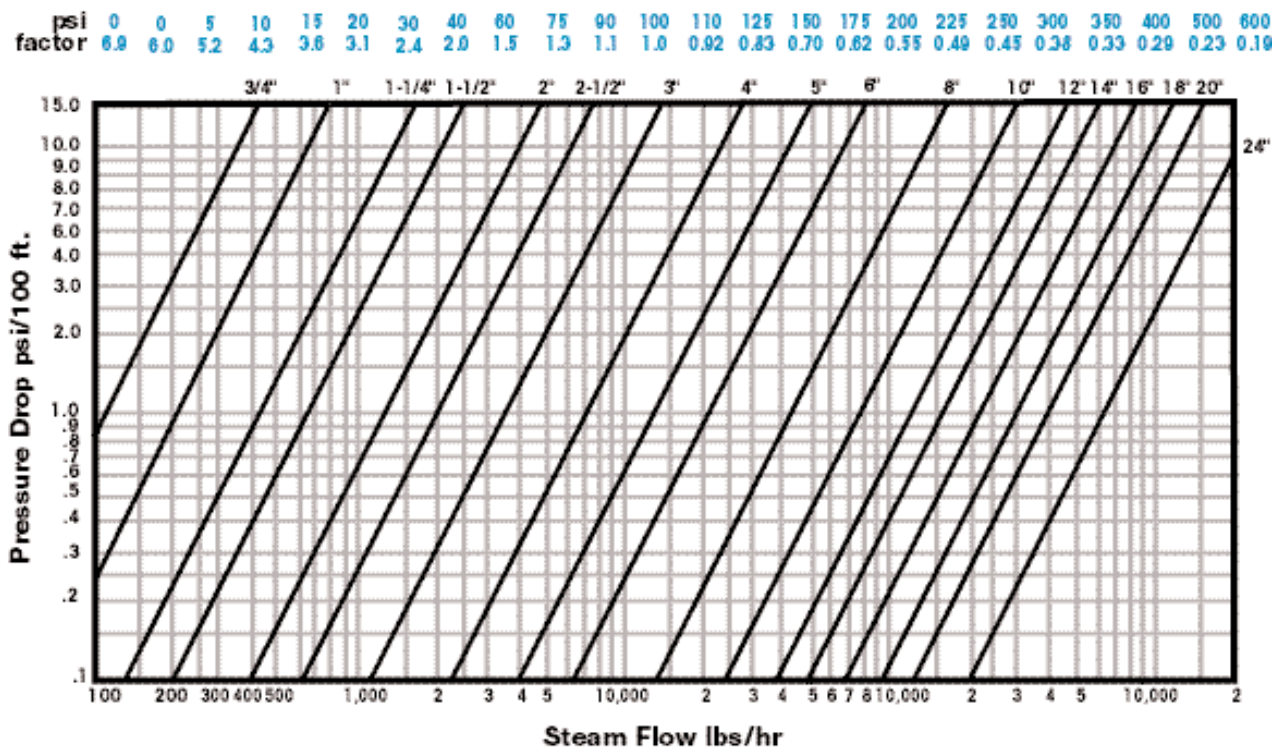
Downstream Piping:

- Enter Velocity Chart at **A** 1000 lbs/hr.
- Follow line to **E** 25 PSIG Outlet Pressure
- Follow line vertically upwards to **F** 2-1/2" Pipe Diameter
- Steam Velocity at **G** shows 5500 ft./min.

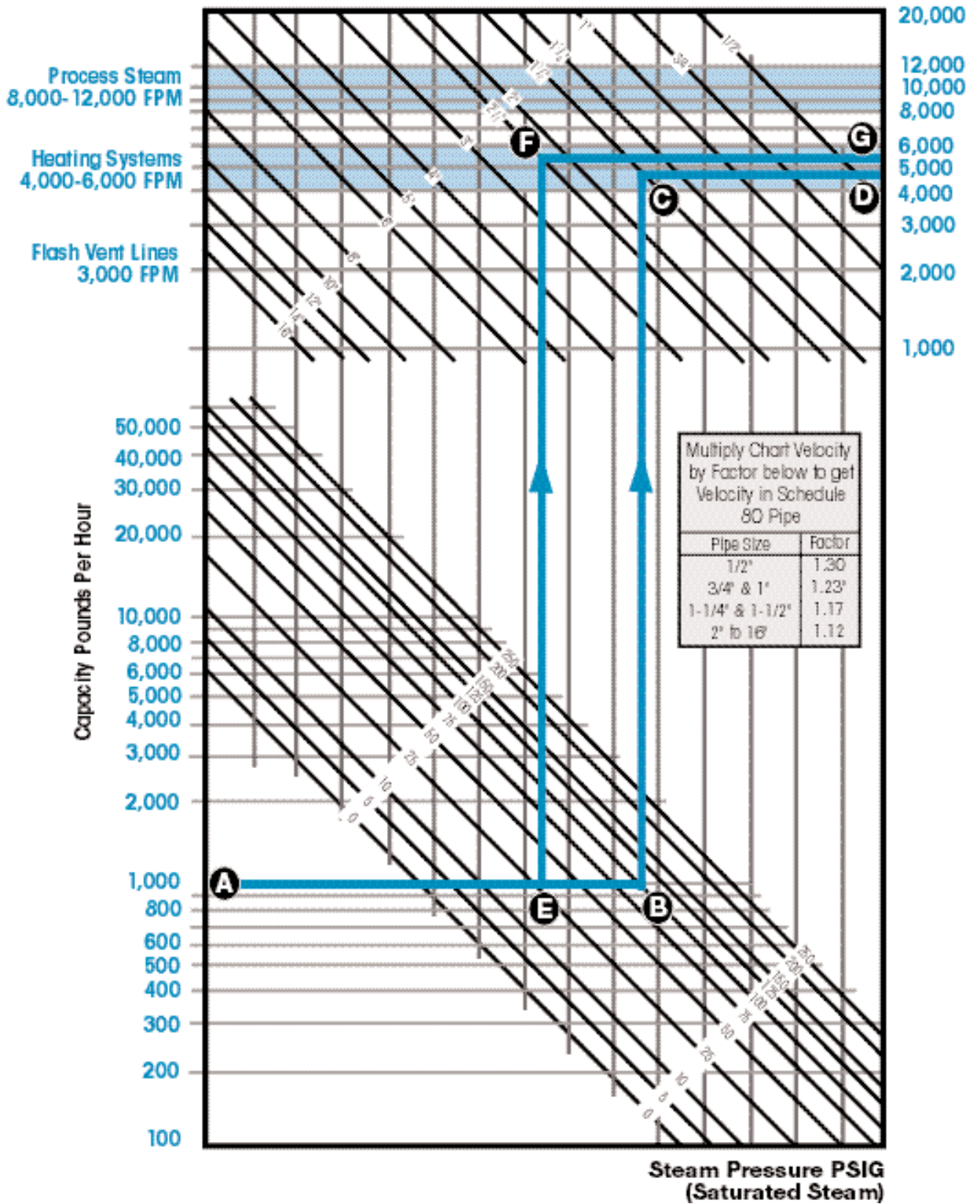
PRESSURE DROP IN SCHEDULE 40 PIPE

100 PSIG Saturated Steam

For other pressures use correction factors



STEAM VELOCITY CHART (Schedule 40 Pipe)



PERCENT (%) FLASH STEAM									
Produced when condensate is discharged to atmosphere or into a flash tank controlled at various pressures									
Condensate Pressure (PSIG)	Flash Tank Pressure (PSIG)								
	0	5	10	20	30	40	60	80	100
5	1.6	0.0							
10	2.9	1.3	0.0						
15	3.9	2.4	1.1						
20	4.9	3.3	2.1	0.0					
30	6.5	5.0	3.7	1.7	0.0				
40	7.8	6.3	5.1	3.0	1.4	0.0			
60	10.0	8.5	7.3	5.3	3.7	2.3	0.0		
80	11.8	10.3	9.1	7.1	5.5	4.2	1.9	0.0	
100	13.3	11.8	10.6	8.7	7.1	5.8	3.5	1.6	0.0
125	14.9	13.5	12.3	10.4	8.8	7.5	5.3	3.4	1.8
150	16.3	14.9	13.7	11.8	10.3	9.0	6.8	4.9	3.3
200	18.7	17.3	16.2	14.3	12.8	11.5	9.4	7.6	6.0
250	20.8	19.4	18.2	16.4	14.9	13.7	11.5	9.8	8.2
300	22.5	21.2	20.0	18.2	16.8	15.5	13.4	11.7	10.2
350	24.1	22.8	21.7	19.9	18.4	17.2	15.1	13.4	11.9
400	25.6	24.2	23.1	21.4	19.9	18.7	16.7	15.0	13.5

SIZING CONDENSATE RETURN LINE, VENT LINE AND FLASH TANK

Velocity in Condensate return Lines should be between 4000-6000 ft/min. In order to size the pipe we must know

Condensate Load (lbs/hr)
Inlet Pressure to Steam Traps (PSIG)
Return Line System Pressure

Example: using Steam Velocity Chart (opposite page):

160 PSIG Steam trap discharging to a 20 PSIG Flash Tank.
Condensate Load is 3000 lbs/hr

From the **Percent Flash Steam Chart** we find that 12.4% of the condensate will flash into steam.

Therefore $.124 \times 3000 = 372$ lbs./hr. of flash steam will be produced

Enter **Condensate Line Sizing** chart at **A** 372 lbs/hr

Move horizontally to point **B** 20 PSIG Flash Tank Pressure

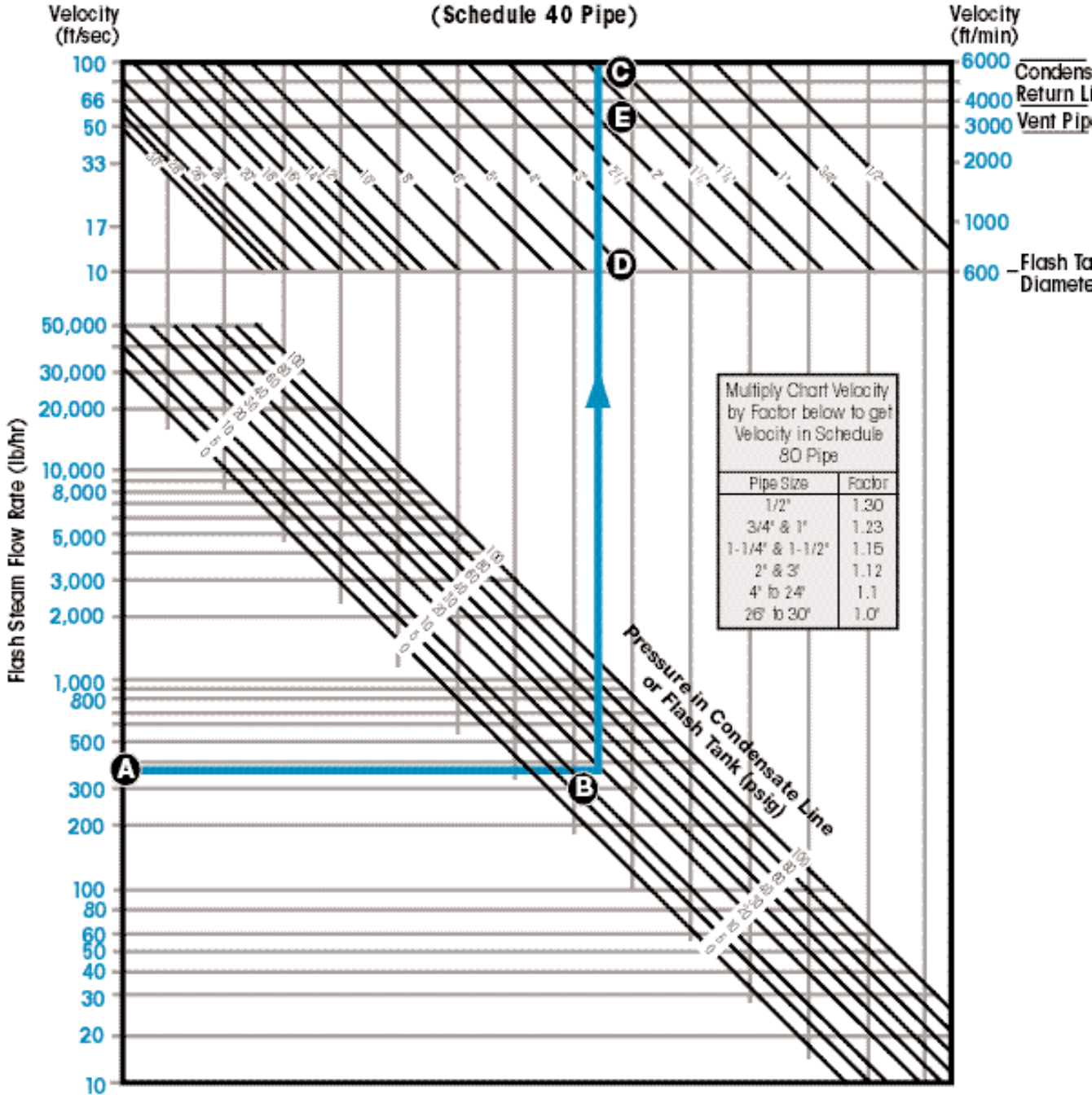
Move vertically upwards to point **D** to determine a 5" Flash tank Tank Diameter is needed to keep velocities less than 600 ft/min.

Continue to move vertically to point **E** to determine that the Vent Line on the Flash Tank should be 2" Diameter in order to keep velocities less than 4000 ft/min.

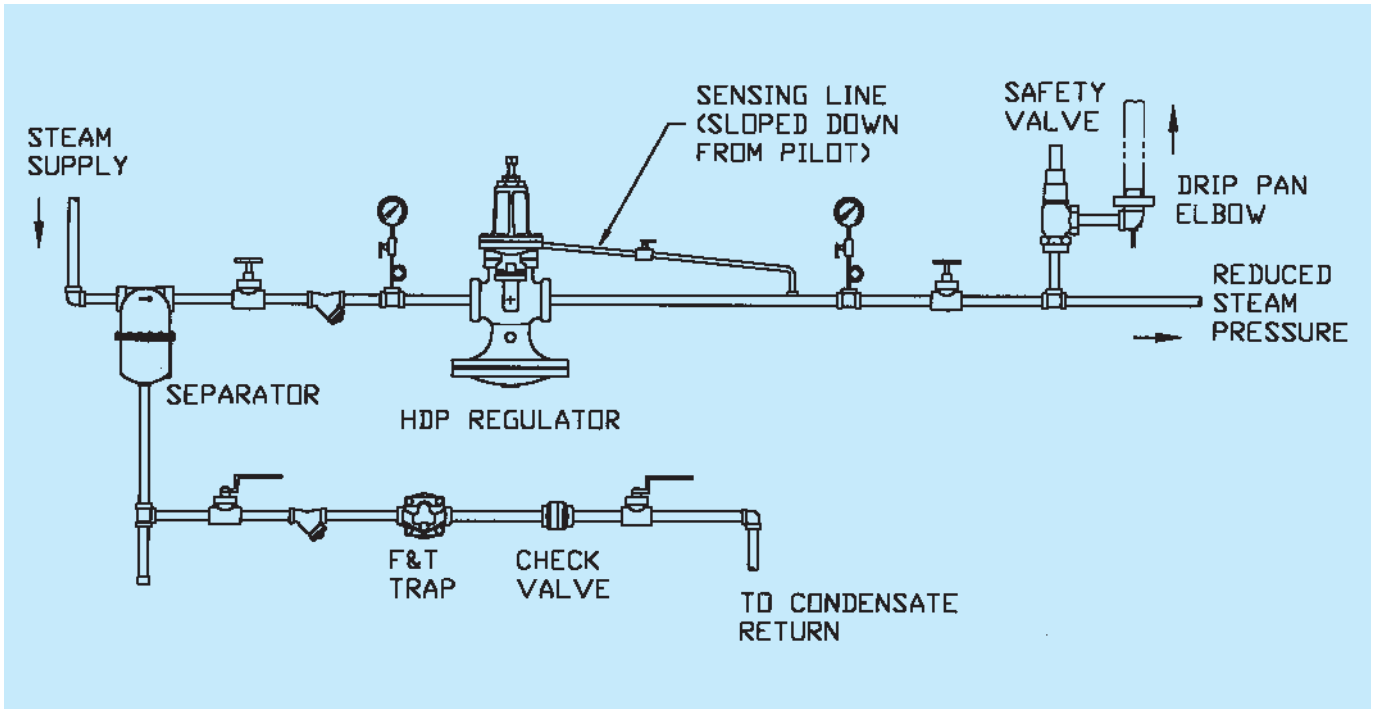
Continue to move vertically to point **C** to determine that the Condensate Line Diameter should be 1-1/2" Diameter to maintain line velocities between 4000 - 6000 ft/min.

Revised 7/2002

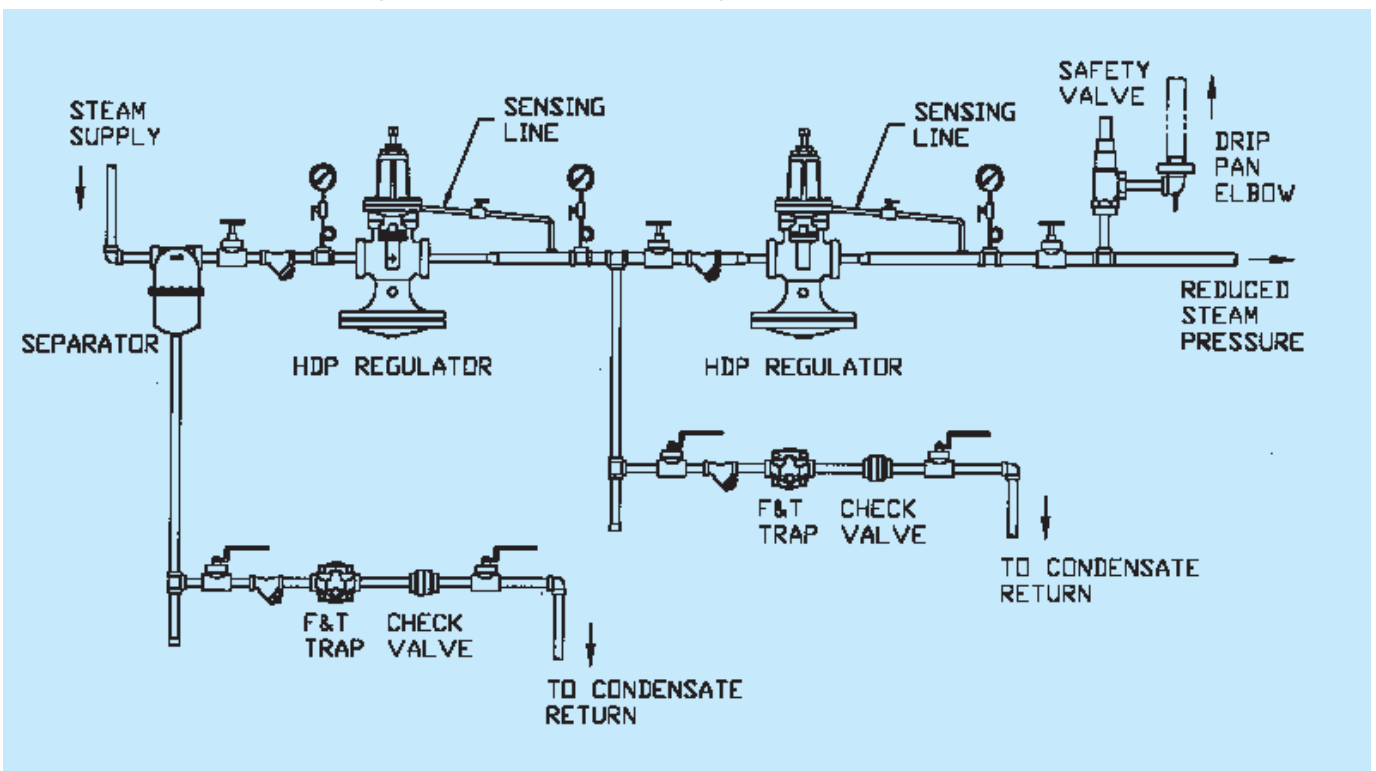
CONDENSATE LINE, FLASH TANK, and VENT LINE SIZING (Schedule 40 Pipe)



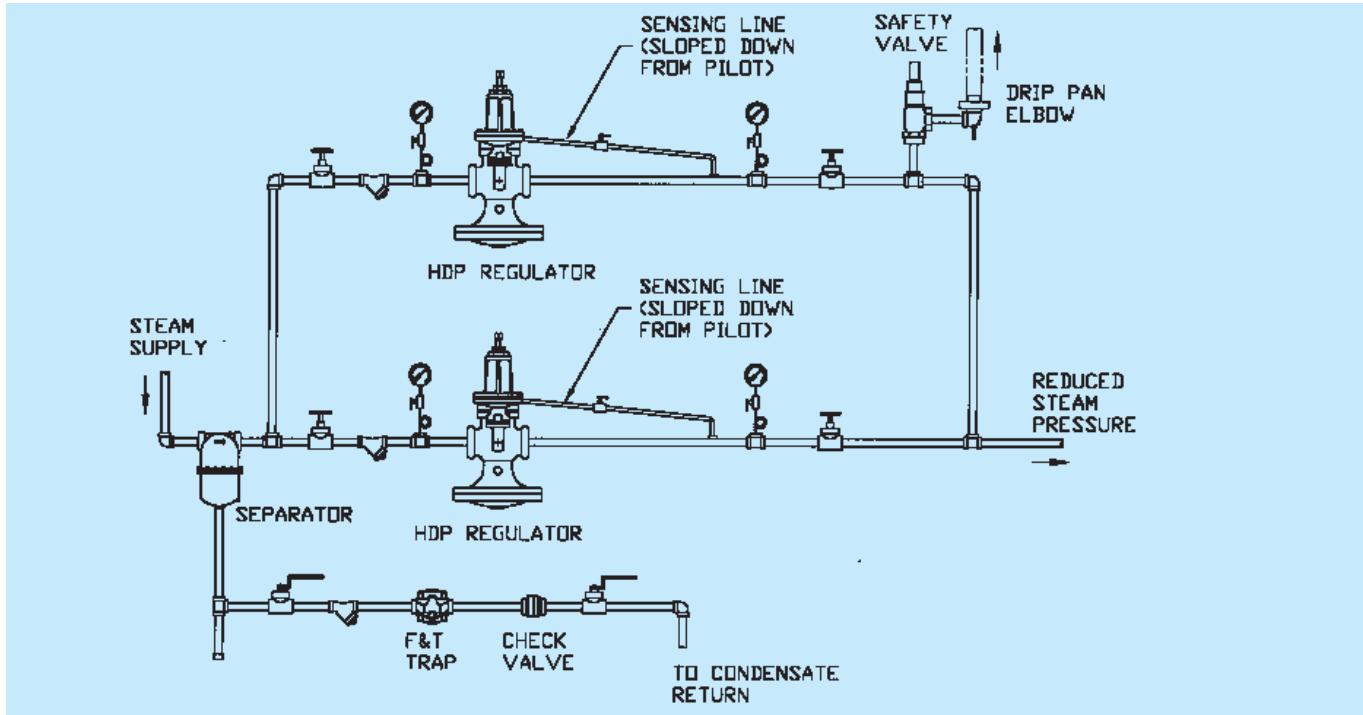
Single Stage Pressure Reducing Station Using Pilot-Operated Regulating Valve



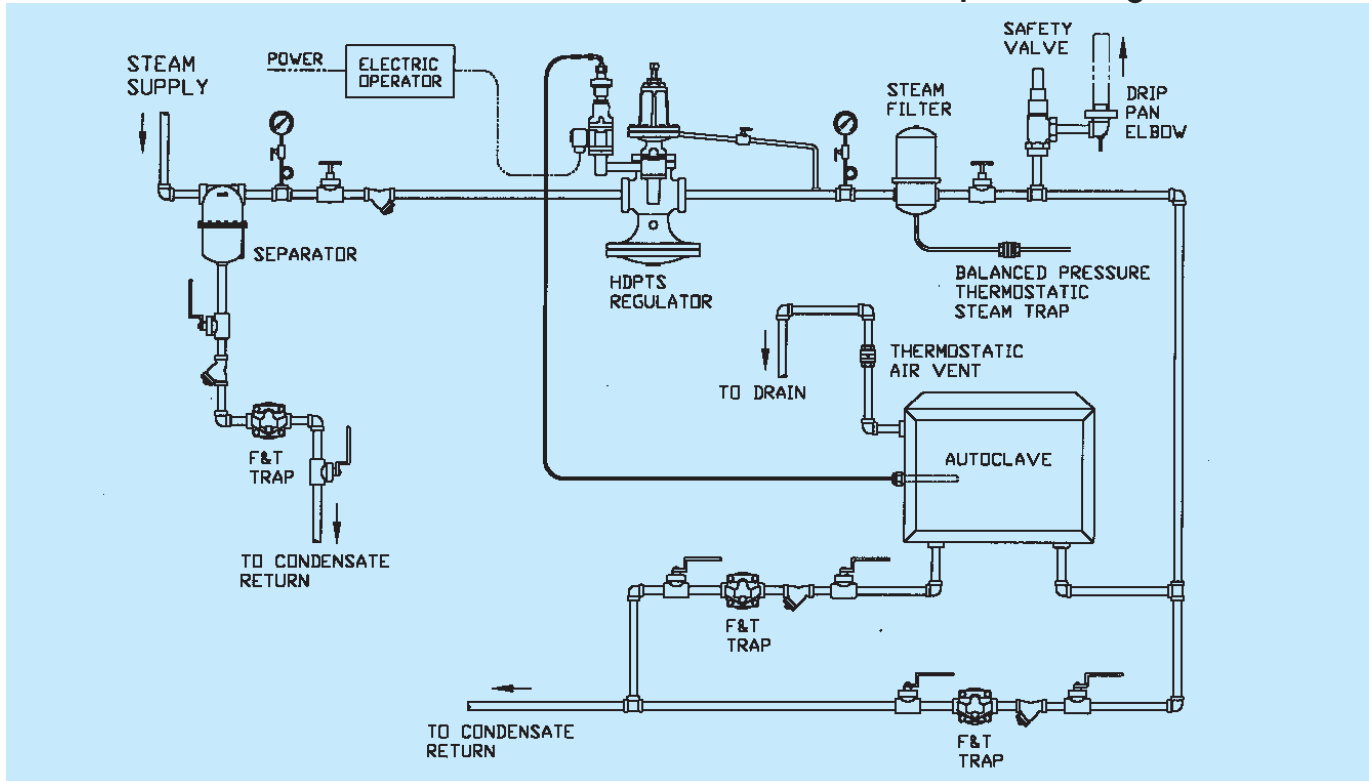
Series Pressure Reducing Stations for Multi-stage Reduction of Pressure



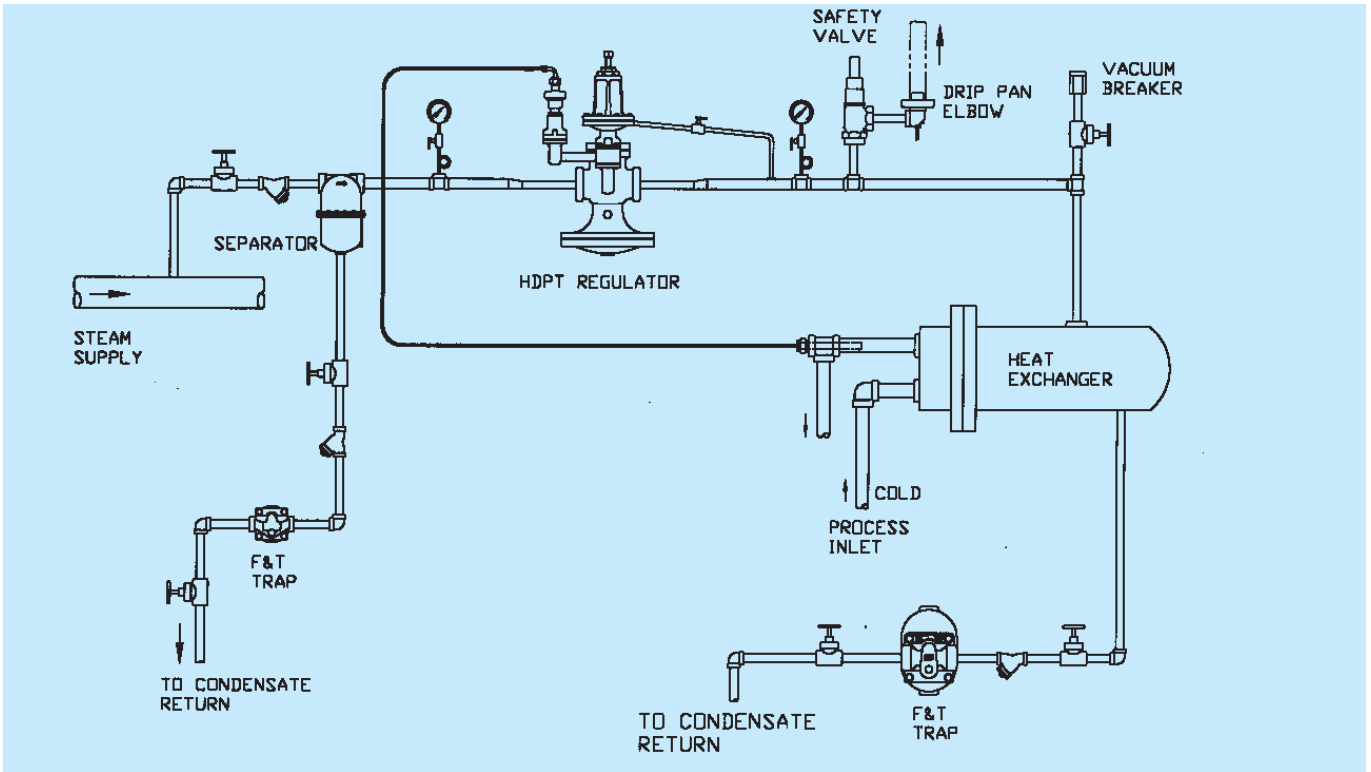
Parallel Pressure Reducing Station Using Two Pilot-Operated Regulating Valves



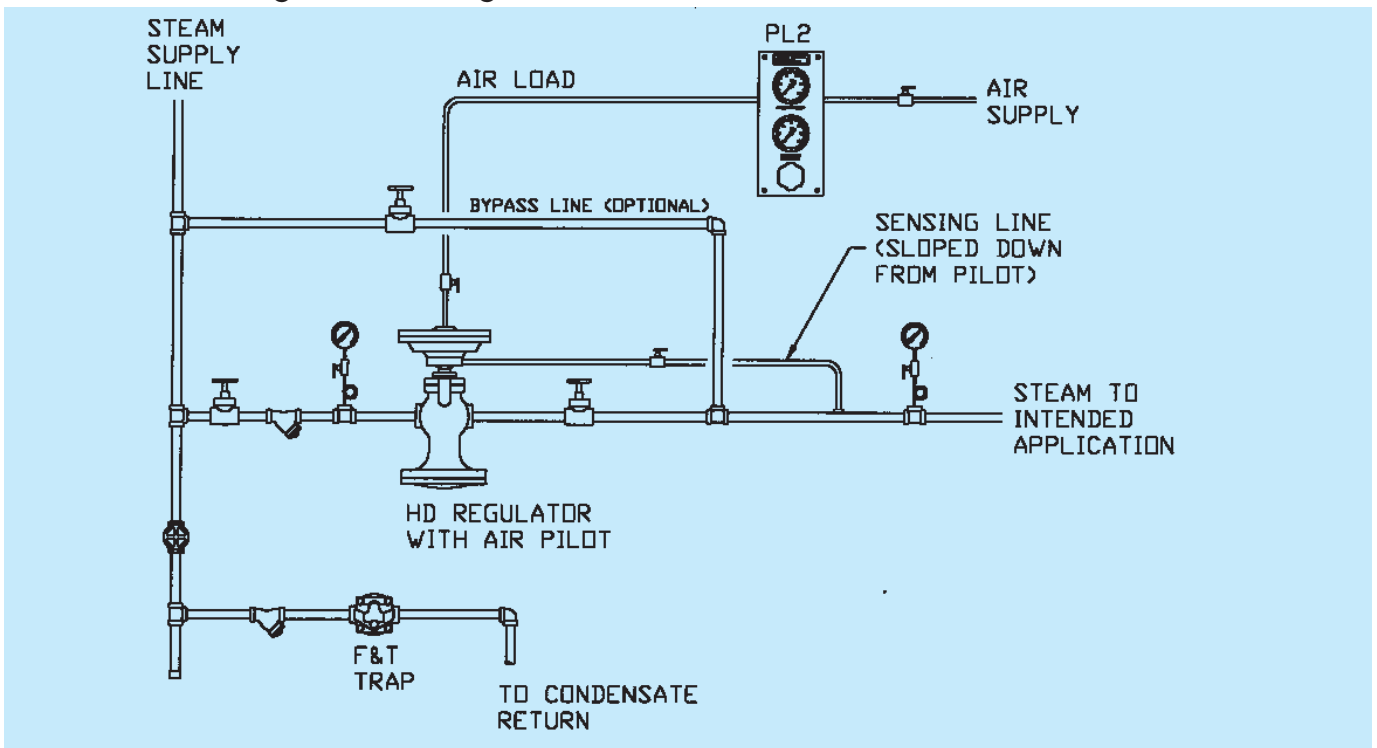
Automatic Control of batch Processor with Electrical Time Sequence Programmer



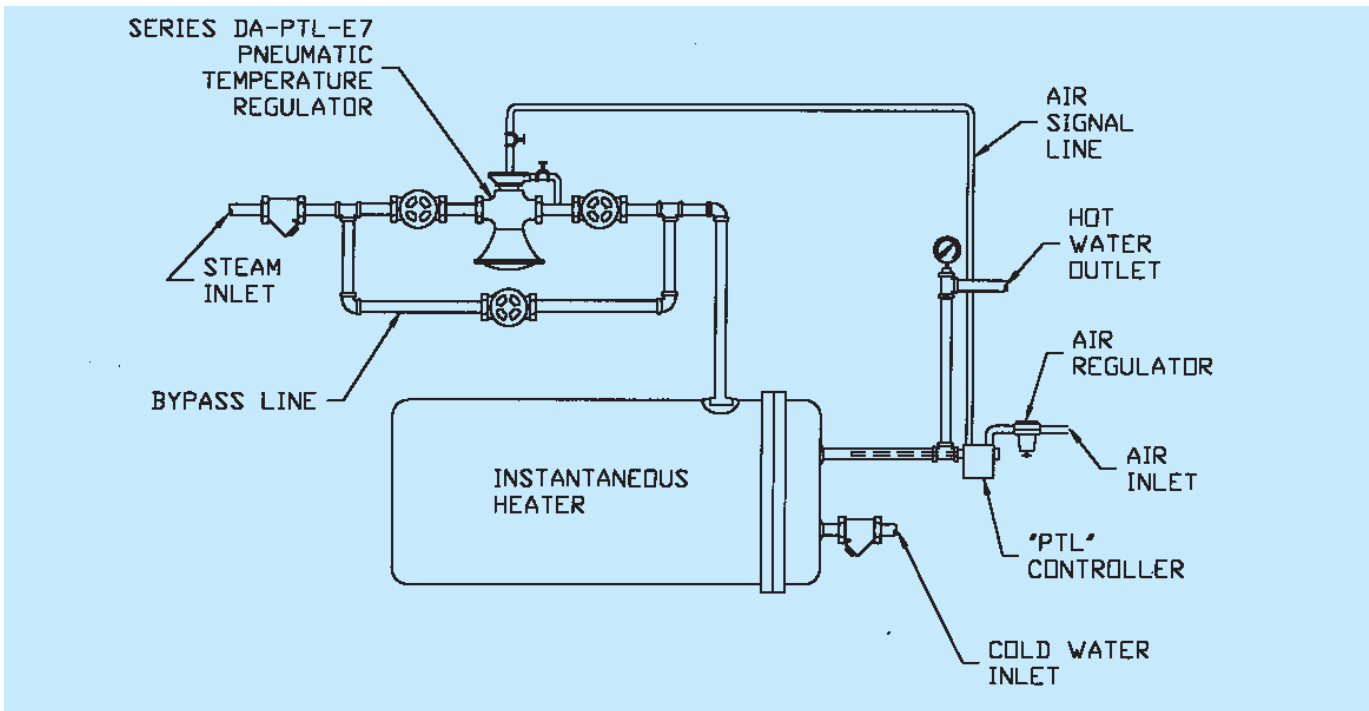
Combined Pressure and Temperature Control of Heat Exchanger



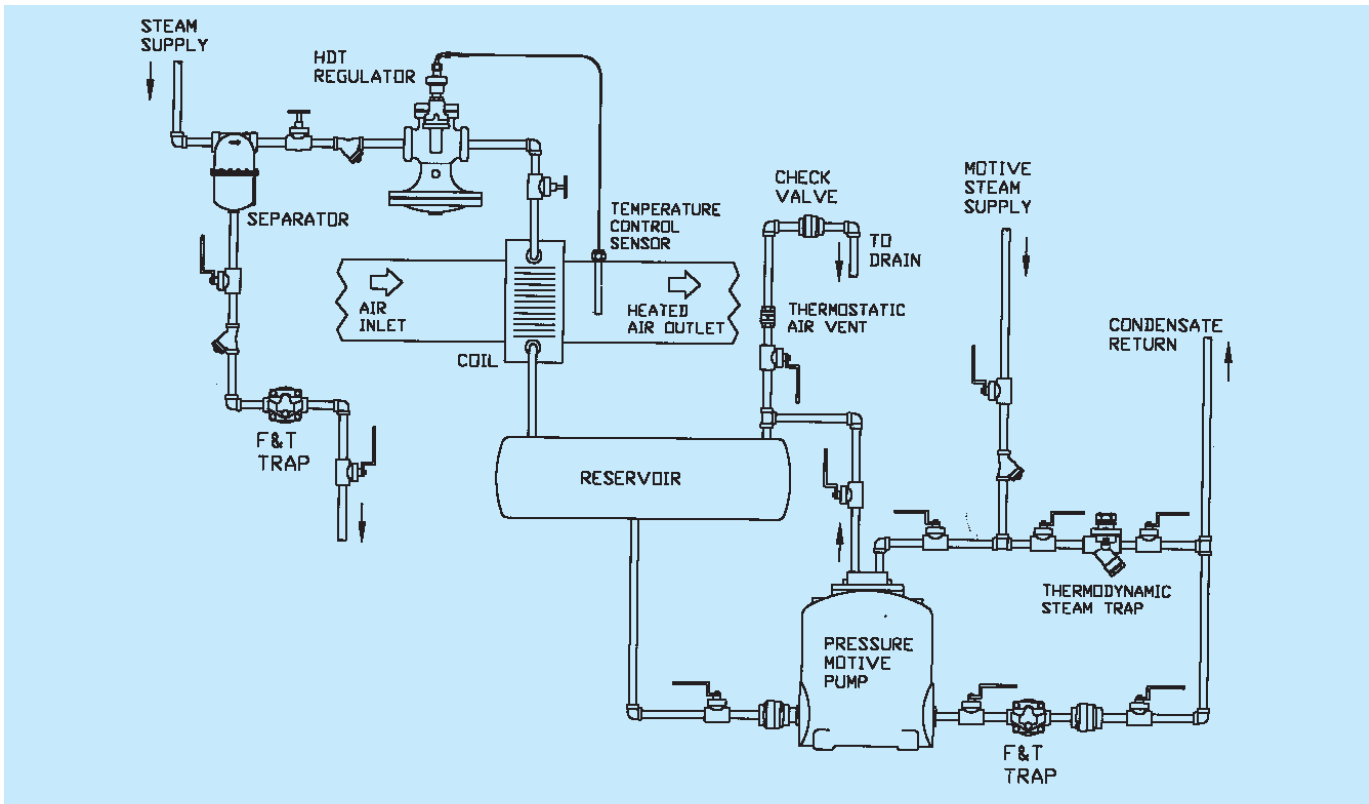
Pressure Reducing Station using Air Pilot and PL2 Control Panel



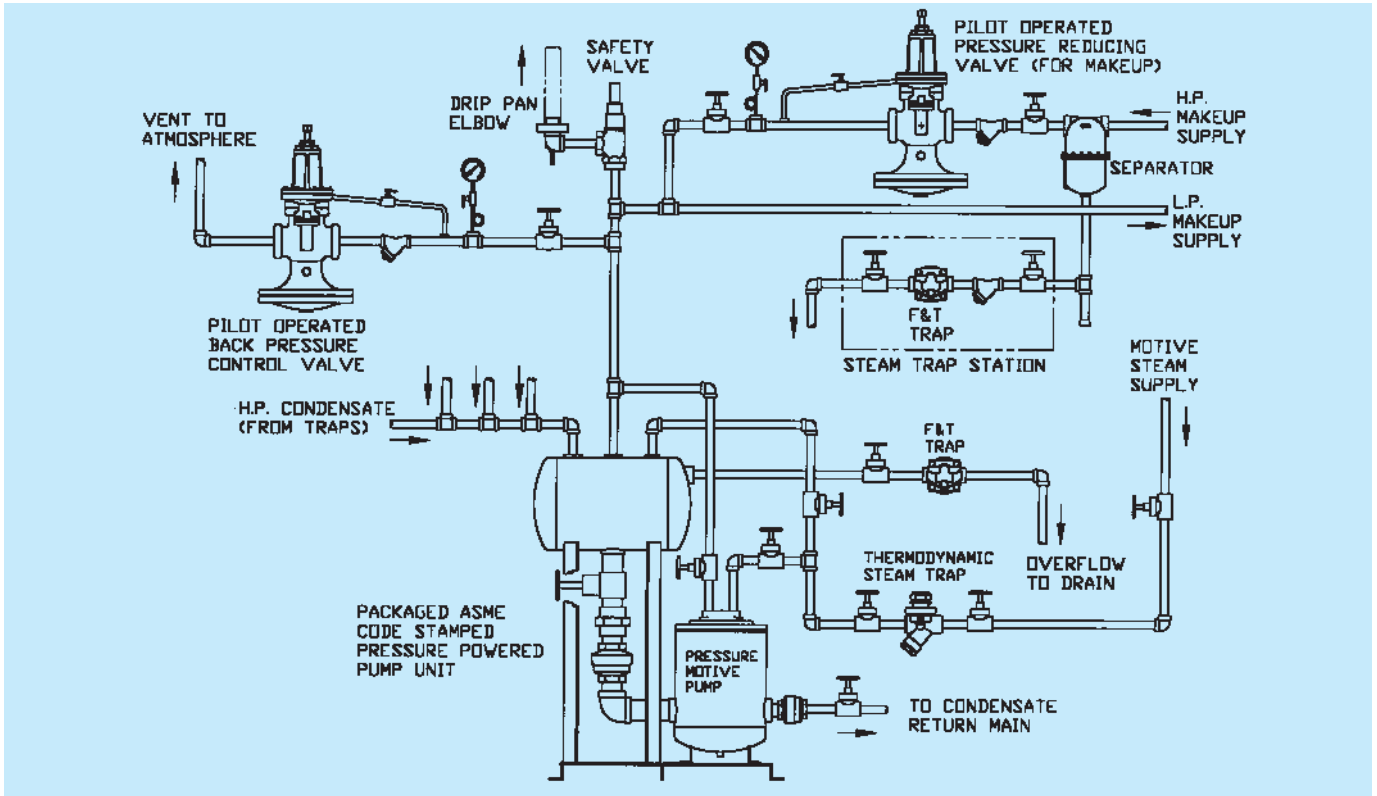
Instantaneous Hot Water Heater with PTL Temperature Controller



Using PMP for Proper Drainage of Heat Exchanger Application



Flash Steam Recovery at Pressure Above or Below Atmospheric Pressure



Pump Trap Combination When Vertical Space is Limited

