How Fast Should Steam Mains be Warmed Up?

	Inches per 100 ft					Inches per 100 ft	
Temp °F	Steel	Wrt. Iron			Temp °F	Steel	Wrt. Iron
0	0	0			520	4.39	4.58
20	.15	.155			540	4.59	4.78
40	.30	.31			560	4.78	4.975
60	.455	.475			580	4.975	5175
80	.61	.63			600	5.17	5.38
100	.77	.80			620	5.365	5.58
120	.915	.96			640	5.565	5.785
140	1.075	1.13			660	5.765	5.99
160	1.235	1.29			680	5.965	6.20
180	1.40	1.46			700	6.17	6.42
200	1.57	1.64			720	6.375	6.625
220	1.73	1.81			740	6.58	6.835
240	1.89	1.98			760	6.79	7.05
260	2.065	2.16			780	6.99	7.275
280	2.23	2.335			800	7.21	7.49
300	2.41	2.52			820	7.415	7.73
320	2.59	2.70			840	7.63	7.93
340	2.76	2.87			860	7.84	8.145
360	2.935	3.05			880	8.055	8.37
380	3.11	3.235			900	8.28	8.60
400	3.29	3.43			920	8.495	8.82
420	3.456	3.62			940	8.72	9.05
440	3.65	3.805			960	8.945	9.28
460	3.835	4.00			980	9.17	9.52
480	4.02	4.19			1000	9.40	9.75
500	4.21	4.39					

The table shows linear expansion in inches per 100 feet of 24” pipe from 0 – 1000°F. It can be noted that for heating up the pipe to 1000°F an expansion of 9.4” is encountered. Rapid heating of such lines would destroy the system and it is, therefore, important to reduce the expansion and temperature stresses as much as possible. An extremely important factor is the ability of the steam traps to discharge condensate as it is formed in the relatively cool pipe. Water hammer must be avoided since it can rupture the pipe or cause valve failure, particularly at the end of the line. Closed gate valves are most susceptible to damage at the end of the line because they can crack at the seat ring when struck by a slug of water. Proper calculating of the heat losses and condensate loads will avoid the backing-up of condensate, and most of the difficulties will be eliminated; however, it is recommended, if the header must be ready for service on short notice, to heat the header with a steam flow through a bypass or a 3/4”, 1” valve first, and only after the pipe has been heated to a certain minimum temperature of approximately 250°F should high pressure steam be admitted to the line. Velan traps operate from 0 to maximum pressure and can handle this job, however, bypasses are recommended, and here the Velan Piping King can offer great savings. The stressing of pipes under such conditions are enormous, and it is important to provide proper expansion loops and expansion joins to keep the effective stress forces within allowable limits.

Stresses can be calculated from a formula:

$$S = C \times E \times TD \text{ psi}$$

where : S = Stress (PSI)
E = tensile elastic modulus (psi)
C = Linear coefficient of expansion of pipe material (in/Δ°F)
TD = The difference between the initial and final temperature of the pipe

Temperature Expansion of Pipes per 100 Feet (inches)

Saturated Steam Pressure	Temperature	Cast Iron	Carbon and carbon Molybdenum
	(°F)		
	20	0.128	0.148
	32	0.209	0.23
29.39	40	0.27	0.3
	60	0.41	0.448
28.89	80	0.55	0.58
27.99	100	0.68	0.753
26.48	120	0.83	0.91
24.04	140	0.97	1.064
20.27	160	1.11	1.2
14.63	180	1.24	1.36
6.45	200	1.39	1.52
0	212	1.48	1.61
2.5	220	1.53	1.68
10.3	240	1.67	1.84
20.7	260	1.82	2.02
34.5	280	1.97	2.18
52.3	300	2.13	2.35
74.9	320	2.268	2530
103.3	340	2.43	2.7
138.3	360	2.59	2.88
180.9	380	2.75	3.06
232.4	400	2.91	3.23
293.7	420	3.09	3.421
366.1	440	3.25	3.595
451.3	460	3.41	3.784
550.3	480	3.57	3.955
664.3	500	3.73	4.151
795.3	520	3.9	4.342
945.3	540	4.08	4.525