

TABLE 1. HEAT LOSSES FROM HORIZONTAL BARE STEEL PIPES
Expressed in Btu per (hour) (linear foot) (Fahrenheit degree difference between the pipe and surrounding still air at 70 F)

NOMINAL PIPE SIZE (INCHES)	HOT WATER				STEAM		
	120 F	150 F	180 F	210 F	227.1 F (5 psig)	299.7 F (50 psig)	337.9 F (100 psig)
	TEMPERATURE DIFFERENCE—F DEG						
	50	80	110	140	157.1	227.7	287.9
1/4	0.455	0.495	0.546	0.584	0.612	0.706	0.760
3/8	0.555	0.595	0.666	0.715	0.743	0.866	0.933
1	0.634	0.743	0.819	0.877	0.919	1.065	1.147
1 1/4	0.847	0.919	1.014	1.085	1.138	1.324	1.425
1 1/2	0.958	1.041	1.148	1.230	1.288	1.492	1.633
2	1.180	1.281	1.412	1.512	1.578	1.840	1.987
2 1/2	1.400	1.532	1.683	1.796	1.883	2.190	2.363
3	1.680	1.825	2.010	2.153	2.260	2.630	2.840
3 1/2	1.900	2.064	2.221	2.433	2.552	2.974	3.215
4	2.118	2.302	2.534	2.717	2.850	3.320	3.590
5	2.530	2.804	3.084	3.303	3.470	4.050	4.385
6	3.036	3.294	3.626	3.886	4.074	4.765	5.100
8	3.880	4.215	4.638	4.960	5.210	6.100	6.610
10	4.760	5.180	5.680	6.090	6.410	7.490	8.115
12	5.590	6.070	6.670	7.145	7.500	8.800	9.530

TABLE 2. HEAT LOSS FROM HORIZONTAL TARNISHED COPPER PIPE¹
Expressed in Btu per (hour) (linear foot) (Fahrenheit degree difference between the pipe and surrounding still air at 70 F)

NOMINAL PIPE SIZE (INCHES)	HOT WATER (Type K Copper Tube)				STEAM (Standard Pipe Size Pipe)		
	120 F	150 F	180 F	210 F	227.1 F (5 psig)	297.7 F (50 psig)	337.9 F (100 psig)
	TEMPERATURE DIFFERENCE—F DEG						
	50	80	110	140	157.1	227.7	287.9
1/4	0.250	0.297	0.300	0.321	0.433	0.500	0.530
3/8	0.340	0.381	0.409	0.429	0.533	0.543	0.654
1	0.440	0.475	0.509	0.536	0.636	0.746	0.803
1 1/4	0.500	0.559	0.618	0.623	0.764	0.878	0.934
1 1/2	0.580	0.658	0.710	0.750	0.904	1.053	1.120
2	0.730	0.825	0.890	0.957	1.101	1.273	1.364
2 1/2	0.880	1.000	1.091	1.143	1.305	1.490	1.605
3	1.040	1.175	1.272	1.343	1.560	1.800	1.940
3 1/2	1.180	1.350	1.454	1.535	1.750	2.020	2.170
4	1.460	1.500	1.635	1.715	1.941	2.240	2.430
4 1/2					2.131	2.465	2.650
5	1.600	1.812	1.980	2.071	2.387	2.770	2.990
6	1.840	2.125	2.270	2.430	2.740	3.210	3.440
8	2.400	2.685	2.910	3.110	3.310	4.050	4.370

TABLE 3. EXTERNAL SURFACE PER LINEAR FOOT OF PIPE

NOMINAL PIPE SIZE (INCHES)	SURFACE AREA (Sq Ft)	NOMINAL PIPE SIZE (INCHES)	SURFACE AREA (Sq Ft)	NOMINAL PIPE SIZE (INCHES)	SURFACE AREA (Sq Ft)
1/4	0.22	2	0.622	5	1.456
3/8	0.275	2 1/2	0.753	6	1.734
1	0.344	3	0.917	8	2.257
1 1/4	0.435	3 1/2	1.047	10	2.817
1 1/2	0.498	4	1.178	12	3.338

TABLE 4. EXTERNAL SURFACE PER LINEAR FOOT OF COPPER TUBING
Outside diameter 1/8 in. greater than nominal size

TUBE SIZE (INCHES)	SURFACE AREA (Sq Ft)	TUBE SIZE (INCHES)	SURFACE AREA (Sq Ft)	TUBE SIZE (INCHES)	SURFACE AREA (Sq Ft)
1/4	0.164	2	0.556	5	1.342
3/8	0.229	2 1/2	0.687	6	1.604
1	0.295	3	0.818	8	2.128
1 1/4	0.360	3 1/2	0.949		
1 1/2	0.426	4	1.080		

perature difference of 169.4 F is found to be 1.624 Btu per (hr) (linear ft) (F deg). The total annual heat loss from the entire line = $1.624 \times 169.4 \times 165$ (linear ft) $\times 4000$ (hr) = 181,600 Mb. (Mb = 1000 Btu.)

Example 2: Coal costing \$11.50 per ton and having a calorific value of 13,000 Btu per pound is being burned in the furnace supplying steam to the pipe line given in the previous example. If the system is operating at an overall efficiency of 55 percent, determine the monetary value of the annual heat loss from the line.

Solution: The cost of heat per 1000 Mb supplied to the system = $1,000,000 \times 11.5$ (dollars) $\div [13,000$ (Btu) $\times 2000$ (lb) $\times 0.55$ (efficiency)] = \$0.804. The total cost of heat lost per year = 0.804×181.6 (thousand Mb) = \$146.00.

INDUSTRIAL AND PIPE INSULATIONS

Insulating materials are made of various substances and are supplied in a number of different forms. Preformed insulations are made in the form of blocks for flat surfaces, segmental pieces for small cylindrical vessels and large pipes, and sectional insulation for smaller pipes. Preformed pipe insulation is regularly supplied in sectional form up to about 12-inch pipe size. Certain types up to 20-inch pipe size are available in sectional form. Sections are either split in half longitudinally or cut through on one side and scored on the inner surface of the other to facilitate application to the pipe. Blanket insulations are used to insulate flat or curved surfaces or large pipes. Pipe fittings and bends are commonly insulated with portions of standard preformed insulations, or, when irregular in contour, with blankets or plastic insulating cements.

Insulation is secured to pipes, flat surfaces, and large vessels in a variety of ways depending on the contour of the surface and the form of the in-

TABLE 5. AREA OF FLANGED FITTINGS, SQUARE FEET^a

NOMINAL PIPE SIZE (INCHES)	FLANGED COUPLING		90 DEG ELL		LONG RADIUS ELL		TEE		CROSS	
	Standard	Extra Heavy	Standard	Extra Heavy	Standard	Extra Heavy	Standard	Extra Heavy	Standard	Extra Heavy
1	0.320	0.438	0.795	1.015	0.892	1.053	1.235	1.575	1.622	2.07
1 1/4	0.383	0.510	0.957	1.098	1.084	1.340	1.481	1.925	1.943	2.53
1 1/2	0.477	0.727	1.174	1.332	1.337	1.874	1.815	2.68	2.38	3.54
2	0.672	0.848	1.65	2.01	1.84	2.16	2.54	3.09	3.32	4.06
2 1/2	0.841	1.107	2.09	2.57	2.32	2.76	3.21	4.05	4.19	5.17
3	0.945	1.484	2.38	3.49	2.68	3.74	3.66	5.33	4.77	6.95
3 1/2	1.123	1.644	2.98	3.96	3.28	4.28	4.48	6.04	5.83	7.89
4	1.344	1.914	3.53	4.64	3.96	4.99	5.41	7.07	7.03	9.24
4 1/2	1.474	2.04	3.95	5.02	4.43	5.46	6.07	7.72	7.87	10.07
5	1.622	2.18	4.44	5.47	5.00	6.02	6.81	8.52	8.82	10.97
6	1.82	2.78	5.13	6.99	5.99	7.76	7.84	10.64	10.08	13.75
8	2.41	3.77	6.98	9.76	8.56	11.09	10.55	14.74	13.44	18.97
10	3.43	5.20	10.18	13.58	12.35	15.60	15.41	20.41	19.58	26.26
12	4.41	6.71	13.08	17.73	16.35	19.76	19.67	26.65	24.87	34.11

^a Including areas of accompanying flanges bolted to the fitting.