

## PIPE-WORK

Pipe-Work to be sized using the following parameters:

Flow Temperature of 82°C.

Return Temperature of 71°C

Maximum Pressure loss of 240 Pa/m.

Maximum Velocity of 1.5 m/s or less

Table C4.12 of the C.I.B.S.E. Guide

Flow Rates are established using the equation:

$$Q = mC_p\Delta t$$

$$m = Q \div C_p\Delta t$$

Where:

- Q = Heat Load (kW)
- M = Mass Flow Rate (Kg/s)
- C<sub>p</sub> = Specific Heat Capacity of Water (4.2KJ/Kg/°C)
- Δt = Temperature Differential between Flow & Return (°C)

## GENERAL REFERENCES

C.I.B.S.E. Guide.

Part 'L' of Building Regulations

**Table C4.12 Medium Grade Steel**

Table C4.12 Flow of water at 75°C in black steel pipes

$M$  = mass flow rate .. .. . kg/s  
 $l_e$  = equivalent length of pipe ( $\zeta = 1$ ) .. m  
 $\Delta p_l$  = pressure loss per unit length .. Pa/m  
 $v$  = velocity .. .. . m/s

**MEDIUM GRADE STEEL**  
**WATER AT 75°C**

\* ( $Re$ ) = 2000

† ( $Re$ ) = 3000

$\Delta p_l$	$v$	10 mm		15 mm		20 mm		25 mm		32 mm		40 mm		50 mm		$v$	$\Delta p_l$	
		$M$	$l_e$	$M$	$l_e$	$M$	$l_e$	$M$	$l_e$	$M$	$l_e$	$M$	$l_e$	$M$	$l_e$			
0.1						0.003	0.1	0.004	0.2	0.011	0.6	0.020*	1.0	0.034†	1.2		0.1	
0.2								0.007	0.4	0.021*	1.0	0.026	0.9	0.048	1.2		0.2	
0.3						0.004	0.2	0.011	0.6	0.022	0.8	0.032	0.9	0.060	1.3		0.3	
0.4						0.006	0.3	0.014*	0.7	0.025	0.8	0.037†	0.9	0.071	1.3		0.4	
0.5						0.007	0.4	0.014	0.6	0.028	0.8	0.042	1.0	0.081	1.4		0.5	
0.6								0.008	0.4	0.016	0.6	0.031†	0.8	0.047	1.0	0.090	1.4	0.6
0.7				0.003	0.2	0.010	0.5	0.017	0.6	0.034	0.8	0.052	1.0	0.098	1.5		0.7	
0.8				0.003	0.2	0.011	0.6	0.018	0.6	0.037	0.8	0.056	1.1	0.106	1.5		0.8	
0.9				0.004	0.2	0.012*	0.7	0.019	0.6	0.039	0.9	0.060	1.1	0.114	1.5		0.9	
1.0				0.004	0.2	0.011	0.5	0.020†	0.6	0.042	0.9	0.063	1.1	0.121	1.5		1.0	
1.5				0.006	0.3	0.014	0.5	0.025	0.6	0.053	0.9	0.080	1.1	0.152	1.6		1.5	
2.0				0.009*	0.4	0.016	0.5	0.029	0.6	0.062	1.0	0.094	1.2	0.179	1.7		2.0	
2.5		0.004	0.2	0.008	0.3	0.018	0.5	0.033	0.7	0.071	1.0	0.107	1.2	0.203	1.7		2.5	
3.0		0.004	0.2	0.009	0.3	0.019†	0.5	0.037	0.7	0.078	1.0	0.119	1.3	0.225	1.8		3.0	
3.5		0.005	0.3	0.010	0.3	0.021	0.5	0.040	0.7	0.086	1.0	0.130	1.3	0.245	1.8		3.5	
4.0	0.05	0.006	0.3	0.011	0.3	0.023	0.5	0.043	0.7	0.092	1.1	0.140	1.3	0.264	1.8		4.0	
4.5		0.007	0.4	0.011	0.3	0.024	0.5	0.046	0.7	0.099	1.1	0.149	1.3	0.282	1.9		4.5	
5.0		0.007*	0.4	0.012	0.3	0.026	0.5	0.049	0.7	0.105	1.1	0.158	1.4	0.299	1.9		5.0	
5.5		0.006	0.3	0.012	0.3	0.027	0.5	0.052	0.7	0.110	1.1	0.167	1.4	0.315	1.9		5.5	
6.0		0.007	0.3	0.013	0.3	0.029	0.5	0.055	0.8	0.116	1.1	0.175	1.4	0.331	1.9		6.0	
6.5		0.007	0.3	0.014	0.3	0.030	0.5	0.057	0.8	0.121	1.1	0.183	1.4	0.346	2.0		6.5	
7.0		0.007	0.3	0.014†	0.4	0.032	0.5	0.060	0.8	0.127	1.1	0.191	1.4	0.361	2.0		7.0	
7.5		0.008	0.3	0.015	0.4	0.033	0.6	0.062	0.8	0.131	1.2	0.198	1.4	0.375	2.0		7.5	
8.0		0.008	0.3	0.015	0.4	0.034	0.6	0.064	0.8	0.136	1.2	0.206	1.4	0.388	2.0		8.0	
8.5		0.008	0.3	0.016	0.4	0.035	0.6	0.066	0.8	0.141	1.2	0.213	1.4	0.401	2.0		8.5	
9.0		0.008	0.3	0.016	0.4	0.036	0.6	0.069	0.8	0.146	1.2	0.220	1.5	0.414	2.0		9.0	
9.5		0.008	0.3	0.017	0.4	0.037	0.6	0.071	0.8	0.150	1.2	0.226	1.5	0.427	2.0		9.5	
10.0		0.009	0.3	0.017	0.4	0.039	0.6	0.073	0.8	0.154	1.2	0.233	1.5	0.439	2.0		10.0	
12.5		0.010	0.3	0.020	0.4	0.044	0.6	0.082	0.8	0.175	1.2	0.263	1.5	0.496	2.1		12.5	
15.0		0.011†	0.3	0.022	0.4	0.049	0.6	0.091	0.8	0.193	1.2	0.291	1.5	0.548	2.1		15.0	
17.5		0.012	0.3	0.024	0.4	0.053	0.6	0.099	0.9	0.210	1.3	0.317	1.6	0.596	2.2		17.5	
20.0		0.012	0.3	0.026	0.4	0.057	0.6	0.107	0.9	0.226	1.3	0.341	1.6	0.641	2.2		20.0	
22.5		0.013	0.3	0.027	0.4	0.061	0.6	0.114	0.9	0.242	1.3	0.363	1.6	0.683	2.2		22.5	
25.0		0.014	0.3	0.029	0.4	0.065	0.6	0.121	0.9	0.256	1.3	0.385	1.6	0.723	2.2		25.0	
27.5		0.015	0.3	0.031	0.4	0.068	0.6	0.128	0.9	0.270	1.3	0.405	1.6	0.761	2.2		27.5	
30.0		0.016	0.3	0.032	0.4	0.071	0.7	0.134	0.9	0.283	1.3	0.425	1.6	0.798	2.2		30.0	
32.5		0.016	0.3	0.034	0.4	0.075	0.7	0.140	0.9	0.295	1.3	0.444	1.6	0.833	2.3		32.5	
35.0		0.017	0.3	0.035	0.4	0.078	0.7	0.146	0.9	0.307	1.3	0.462	1.7	0.867	2.3		35.0	
37.5	0.15	0.018	0.3	0.036	0.4	0.081	0.7	0.151	0.9	0.319	1.4	0.479	1.7	0.899	2.3		37.5	
40.0		0.018	0.3	0.038	0.4	0.084	0.7	0.157	0.9	0.330	1.4	0.496	1.7	0.931	2.3		40.0	
42.5		0.019	0.3	0.039	0.4	0.087	0.7	0.162	0.9	0.341	1.4	0.513	1.7	0.962	2.3		42.5	
45.0		0.020	0.3	0.040	0.5	0.089	0.7	0.167	0.9	0.352	1.4	0.529	1.7	0.992	2.3		45.0	
47.5		0.020	0.3	0.041	0.5	0.092	0.7	0.172	0.9	0.363	1.4	0.545	1.7	1.02	2.3		47.5	
50.0		0.021	0.3	0.043	0.5	0.095	0.7	0.177	1.0	0.373	1.4	0.560	1.7	1.05	2.3		50.0	
52.5		0.022	0.3	0.044	0.5	0.097	0.7	0.182	1.0	0.383	1.4	0.575	1.7	1.08	2.3		52.5	
55.0		0.022	0.3	0.045	0.5	0.100	0.7	0.187	1.0	0.392	1.4	0.589	1.7	1.10	2.3		55.0	
57.5		0.023	0.3	0.046	0.5	0.102	0.7	0.191	1.0	0.402	1.4	0.603	1.7	1.13	2.4		57.5	
60.0		0.023	0.3	0.047	0.5	0.105	0.7	0.196	1.0	0.411	1.4	0.617	1.7	1.16	2.4		60.0	
62.5		0.024	0.3	0.048	0.5	0.107	0.7	0.200	1.0	0.420	1.4	0.631	1.7	1.18	2.4		62.5	
65.0		0.024	0.3	0.049	0.5	0.109	0.7	0.204	1.0	0.429	1.4	0.644	1.7	1.21	2.4		65.0	
67.5		0.025	0.3	0.050	0.5	0.112	0.7	0.208	1.0	0.438	1.4	0.657	1.7	1.23	2.4		67.5	
70.0		0.025	0.3	0.051	0.5	0.114	0.7	0.213	1.0	0.447	1.4	0.670	1.7	1.26	2.4		70.0	
72.5		0.026	0.3	0.052	0.5	0.116	0.7	0.217	1.0	0.455	1.4	0.683	1.7	1.28	2.4		72.5	
75.0		0.026	0.3	0.053	0.5	0.118	0.7	0.221	1.0	0.464	1.4	0.696	1.8	1.30	2.4		75.0	
77.5		0.027	0.3	0.054	0.5	0.120	0.7	0.225	1.0	0.472	1.4	0.708	1.8	1.32	2.4		77.5	

Table C4.12 Flow of water at 75°C in black steel pipes — continued

**MEDIUM GRADE STEEL**  
**WATER AT 75°C**

$\Delta p_f$	$v$	10 mm		15 mm		20 mm		25 mm		32 mm		40 mm		50 mm		$v$	$\Delta p_f$
		$M$	$l_e$	$M$	$l_e$	$M$	$l_e$	$M$	$l_e$	$M$	$l_e$	$M$	$l_e$	$M$	$l_e$		
80-0	0-30	0-027	0-3	0-055	0-5	0-122	0-7	0-228	1-0	0-480	1-4	0-720	1-8	1-35	2-4	80-0	
82-5		0-028	0-3	0-056	0-5	0-124	0-7	0-232	1-0	0-488	1-4	0-732	1-8	1-37	2-4	82-5	
85-0		0-028	0-3	0-057	0-5	0-126	0-7	0-236	1-0	0-496	1-4	0-743	1-8	1-39	2-4	85-0	
87-5		0-029	0-3	0-058	0-5	0-128	0-7	0-240	1-0	0-503	1-4	0-755	1-8	1-41	2-4	87-5	
90-0		0-029	0-3	0-059	0-5	0-130	0-7	0-243	1-0	0-511	1-4	0-766	1-8	1-43	2-4	90-0	
92-5		0-029	0-3	0-060	0-5	0-132	0-7	0-247	1-0	0-518	1-5	0-778	1-8	1-45	2-4	92-5	
95-0		0-030	0-3	0-061	0-5	0-134	0-7	0-251	1-0	0-526	1-5	0-789	1-8	1-48	2-4	95-0	
97-5		0-030	0-3	0-062	0-5	0-136	0-7	0-254	1-0	0-533	1-5	0-800	1-8	1-50	2-4	97-5	
100-0		0-031	0-3	0-062	0-5	0-138	0-7	0-258	1-0	0-540	1-5	0-810	1-8	1-52	2-4	100-0	
120-0		0-034	0-3	0-069	0-5	0-152	0-7	0-284	1-0	0-595	1-5	0-893	1-8	1-67	2-4	120-0	
140-0	0-50	0-037	0-3	0-075	0-5	0-165	0-8	0-308	1-0	0-646	1-5	0-968	1-8	1-81	2-5	140-0	
160-0		0-040	0-4	0-081	0-5	0-178	0-8	0-331	1-0	0-693	1-5	1-04	1-8	1-94	2-5	160-0	
180-0		0-042	0-4	0-086	0-5	0-189	0-8	0-353	1-0	0-738	1-5	1-11	1-8	2-06	2-5	180-0	
200-0		0-045	0-4	0-091	0-5	0-200	0-8	0-373	1-1	0-780	1-5	1-17	1-9	2-18	2-5	200-0	
220-0		0-047	0-4	0-096	0-5	0-211	0-8	0-392	1-1	0-820	1-5	1-28	1-9	2-29	2-5	220-0	
240-0		0-050	0-4	0-100	0-5	0-221	0-8	0-411	1-1	0-858	1-5	1-29	1-9	2-40	2-5	240-0	
260-0		0-052	0-4	0-105	0-5	0-230	0-8	0-428	1-1	0-895	1-5	1-34	1-9	2-50	2-5	260-0	
280-0		0-054	0-4	0-109	0-5	0-239	0-8	0-445	1-1	0-931	1-5	1-39	1-9	2-60	2-6	280-0	
300-0		0-056	0-4	0-113	0-5	0-248	0-8	0-462	1-1	0-965	1-5	1-44	1-9	2-69	2-6	300-0	
320-0		0-058	0-4	0-117	0-5	0-257	0-8	0-478	1-1	0-998	1-6	1-49	1-9	2-78	2-6	320-0	
340-0	0-50	0-060	0-4	0-121	0-5	0-265	0-8	0-493	1-1	1-03	1-6	1-54	1-9	2-87	2-6	340-0	
360-0		0-062	0-4	0-125	0-5	0-273	0-8	0-508	1-1	1-06	1-6	1-59	1-9	2-96	2-6	360-0	
380-0		0-064	0-4	0-128	0-5	0-281	0-8	0-523	1-1	1-09	1-6	1-63	1-9	3-04	2-6	380-0	
400-0		0-065	0-4	0-132	0-5	0-289	0-8	0-537	1-1	1-12	1-6	1-68	1-9	3-12	2-6	400-0	
420-0		0-067	0-4	0-135	0-5	0-297	0-8	0-551	1-1	1-15	1-6	1-72	1-9	3-20	2-6	420-0	
440-0		0-069	0-4	0-139	0-5	0-304	0-8	0-564	1-1	1-18	1-6	1-76	1-9	3-28	2-6	440-0	
460-0		0-070	0-4	0-142	0-5	0-311	0-8	0-578	1-1	1-21	1-6	1-80	1-9	3-36	2-6	460-0	
480-0		0-072	0-4	0-145	0-5	0-318	0-8	0-591	1-1	1-23	1-6	1-84	1-9	3-43	2-6	480-0	
500-0		0-074	0-4	0-148	0-5	0-325	0-8	0-603	1-1	1-25	1-6	1-88	1-9	3-51	2-6	500-0	
520-0		0-075	0-4	0-151	0-5	0-332	0-8	0-616	1-1	1-29	1-6	1-92	1-9	3-58	2-6	520-0	
540-0	0-50	0-077	0-4	0-154	0-6	0-338	0-8	0-628	1-1	1-31	1-6	1-96	1-9	3-65	2-6	540-0	
560-0		0-078	0-4	0-157	0-6	0-345	0-8	0-640	1-1	1-34	1-6	2-00	1-9	3-72	2-6	560-0	
580-0		0-080	0-4	0-160	0-6	0-351	0-8	0-652	1-1	1-36	1-6	2-03	1-9	3-78	2-6	580-0	
600-0		0-081	0-4	0-163	0-6	0-355	0-8	0-664	1-1	1-38	1-6	2-07	1-9	3-85	2-6	600-0	
620-0		0-082	0-4	0-166	0-6	0-364	0-8	0-675	1-1	1-41	1-6	2-10	1-9	3-92	2-6	620-0	
640-0		0-084	0-4	0-169	0-6	0-370	0-8	0-686	1-1	1-43	1-6	2-14	1-9	3-98	2-6	640-0	
660-0		0-085	0-4	0-172	0-6	0-376	0-8	0-697	1-1	1-45	1-6	2-17	1-9	4-04	2-6	660-0	
680-0		0-087	0-4	0-174	0-6	0-382	0-8	0-708	1-1	1-48	1-6	2-21	1-9	4-11	2-6	680-0	
700-0		0-088	0-4	0-177	0-6	0-388	0-8	0-719	1-1	1-50	1-6	2-24	1-9	4-17	2-6	700-0	
720-0		0-089	0-4	0-180	0-6	0-393	0-8	0-730	1-1	1-52	1-6	2-27	1-9	4-23	2-6	720-0	
740-0	1-0	0-091	0-4	0-182	0-6	0-399	0-8	0-740	1-1	1-54	1-6	2-31	2-0	4-29	2-6	740-0	
760-0		0-092	0-4	0-185	0-6	0-405	0-8	0-750	1-1	1-56	1-6	2-34	2-0	4-35	2-6	760-0	
780-0		0-093	0-4	0-187	0-6	0-410	0-8	0-761	1-1	1-59	1-6	2-37	2-0	4-41	2-6	780-0	
800-0		0-094	0-4	0-190	0-6	0-416	0-8	0-771	1-1	1-61	1-6	2-40	2-0	4-46	2-6	800-0	
820-0		0-096	0-4	0-192	0-6	0-421	0-8	0-780	1-1	1-63	1-6	2-43	2-0	4-52	2-6	820-0	
840-0		0-097	0-4	0-195	0-6	0-426	0-8	0-790	1-1	1-65	1-6	2-46	2-0	4-58	2-6	840-0	
860-0		0-098	0-4	0-197	0-6	0-431	0-8	0-800	1-1	1-67	1-6	2-49	2-0	4-63	2-6	860-0	
880-0		0-099	0-4	0-200	0-6	0-437	0-8	0-810	1-1	1-69	1-6	2-52	2-0	4-69	2-6	880-0	
900-0		0-100	0-4	0-202	0-6	0-442	0-8	0-819	1-1	1-71	1-6	2-55	2-0	4-74	2-6	900-0	
920-0		0-102	0-4	0-204	0-6	0-447	0-8	0-828	1-1	1-73	1-6	2-58	2-0	4-80	2-6	920-0	
940-0	1-0	0-103	0-4	0-207	0-6	0-452	0-8	0-838	1-1	1-75	1-6	2-61	2-0	4-85	2-6	940-0	
960-0		0-104	0-4	0-209	0-6	0-457	0-8	0-847	1-1	1-76	1-6	2-64	2-0	4-90	2-6	960-0	
980-0		0-105	0-4	0-211	0-6	0-462	0-8	0-856	1-1	1-78	1-6	2-66	2-0	4-95	2-6	980-0	
1 000-0		0-106	0-4	0-213	0-6	0-467	0-8	0-865	1-1	1-80	1-6	2-69	2-0	5-00	2-6	1 000-0	
1 100-0		0-112	0-4	0-224	0-6	0-490	0-8	0-909	1-1	1-89	1-6	2-83	2-0	5-26	2-7	1 100-0	
1 200-0		0-117	0-4	0-235	0-6	0-513	0-8	0-950	1-1	1-98	1-6	2-96	2-0	5-49	2-7	1 200-0	
1 300-0		0-122	0-4	0-245	0-6	0-535	0-8	0-990	1-1	2-06	1-6	3-08	2-0	5-72	2-7	1 300-0	
1 400-0		0-127	0-4	0-254	0-6	0-555	0-8	1-03	1-1	2-14	1-6	3-20	2-0	5-94	2-7	1 400-0	
1 500-0		0-131	0-4	0-263	0-6	0-576	0-8	1-07	1-1	2-22	1-6	3-31	2-0	6-16	2-7	1 500-0	
1 600-0		0-136	0-4	0-272	0-6	0-595	0-9	1-10	1-1	2-29	1-6	3-42	2-0	6-36	2-7	1 600-0	
1 700-0	1-0	0-140	0-4	0-281	0-6	0-614	0-9	1-14	1-2	2-37	1-6	3-53	2-0	6-56	2-7	1 700-0	
1 800-0		0-144	0-4	0-290	0-6	0-632	0-9	1-17	1-2	2-44	1-6	3-64	2-0	6-76	2-7	1 800-0	
1 900-0		0-148	0-4	0-298	0-6	0-650	0-9	1-20	1-2	2-50	1-6	3-74	2-0	6-94	2-7	1 900-0	

Table C4.12 Flow of water at 75°C in black steel pipes – continued

$M$  = mass flow rate .. .. kg/s  
 $l_e$  = equivalent length of pipe ( $\xi = 1$ ) .. m  
 $\Delta p_l$  = pressure loss per unit length .. Pa/m  
 $v$  = velocity .. .. m/s

**MEDIUM GRADE STEEL**  
**WATER AT 75°C**

$\Delta p_l$	$v$	65 mm		80 mm		90 mm		100 mm		125 mm		150 mm		$v$	$\Delta p_l$
		$M$	$l_e$	$M$	$l_e$	$M$	$l_e$	$M$	$l_e$	$M$	$l_e$	$M$	$l_e$		
0.1	0.05	0.065	1.6	0.102	2.0	0.151	2.5	0.210	3.0	0.375	4.1	0.612	5.3	0.05	0.1
0.2		0.097	1.8	0.152	2.3	0.225	2.8	0.312	3.3	0.557	4.5	0.906	5.8		0.2
0.3		0.123	1.9	0.191	2.4	0.284	3.0	0.394	3.5	0.701	4.8	1.14	6.1		0.3
0.4		0.145	2.0	0.226	2.5	0.334	3.1	0.463	3.7	0.824	5.0	1.34	6.4		0.4
0.5		0.165	2.0	0.256	2.6	0.379	3.2	0.525	3.8	0.934	5.0	1.52	6.5		0.5
0.6	0.15	0.183	2.1	0.284	2.6	0.420	3.2	0.582	3.9	1.03	5.2	1.68	6.7	0.15	0.6
0.7		0.200	2.1	0.310	2.7	0.459	3.3	0.635	3.9	1.13	5.3	1.83	6.8		0.7
0.8		0.216	2.2	0.335	2.8	0.494	3.4	0.684	4.0	1.21	5.4	1.97	6.9		0.8
0.9		0.231	2.2	0.358	2.8	0.528	3.4	0.731	4.1	1.30	5.4	2.10	7.0		0.9
1.0		0.245	2.2	0.379	2.8	0.560	3.5	0.775	4.1	1.38	5.5	2.23	7.0		1.0
1.5	0.15	0.308	2.4	0.476	3.1	0.703	3.6	0.972	4.3	1.72	5.8	2.78	7.3	0.15	1.5
2.0		0.362	2.4	0.559	3.1	0.825	3.8	1.14	4.4	2.02	5.9	3.26	7.6		2.0
2.5		0.410	2.5	0.633	3.2	0.933	3.8	1.29	4.5	2.28	6.1	3.68	7.7		2.5
3.0		0.454	2.6	0.701	3.2	1.03	3.9	1.42	4.6	2.52	6.2	4.07	7.8		3.0
3.5		0.495	2.6	0.763	3.3	1.12	4.0	1.55	4.7	2.74	6.2	4.42	7.9		3.5
4.0	0.15	0.533	2.6	0.821	3.3	1.21	4.0	1.67	4.8	2.95	6.3	4.75	8.0	0.15	4.0
4.5		0.568	2.7	0.876	3.4	1.29	4.1	1.78	4.8	3.12	6.4	5.07	8.1		4.5
5.0		0.602	2.7	0.929	3.4	1.37	4.1	1.88	4.8	3.32	6.4	5.36	8.2		5.0
5.5		0.635	2.7	0.978	3.4	1.44	4.2	1.98	4.9	3.50	6.5	5.64	8.2		5.5
6.0		0.666	2.8	1.03	3.4	1.51	4.2	2.08	4.9	3.67	6.5	5.92	8.3		6.0
6.5	0.15	0.696	2.8	1.07	3.5	1.58	4.2	2.17	5.0	3.83	6.6	6.18	8.3	0.15	6.5
7.0		0.725	2.8	1.12	3.5	1.64	4.2	2.26	5.0	3.99	6.6	6.43	8.4		7.0
7.5		0.753	2.8	1.16	3.5	1.70	4.3	2.35	5.0	4.14	6.7	6.67	8.4		7.5
8.0		0.780	2.8	1.20	3.5	1.76	4.3	2.43	5.0	4.29	6.7	6.90	8.5		8.0
8.5		0.806	2.9	1.24	3.6	1.82	4.3	2.51	5.1	4.43	6.7	7.13	8.5		8.5
9.0	0.30	0.832	2.9	1.28	3.6	1.88	4.3	2.59	5.1	4.57	6.8	7.35	8.5	0.30	9.0
9.5		0.857	2.9	1.32	3.6	1.94	4.4	2.67	5.1	4.70	6.8	7.57	8.6		9.5
10.0		0.881	2.9	1.36	3.6	1.99	4.4	2.74	5.1	4.83	6.8	7.78	8.6		10.0
12.5		0.995	3.0	1.53	3.7	2.25	4.5	3.09	5.2	5.44	6.9	8.76	8.7		12.5
15.0		1.19	3.0	1.69	3.7	2.48	4.5	3.41	5.3	6.00	7.0	9.65	8.8		15.0
17.5	0.30	1.19	3.1	1.83	3.8	2.69	4.6	3.70	5.4	6.51	7.1	10.5	8.9	0.30	17.5
20.0		1.28	3.1	1.97	3.8	2.89	4.6	3.98	5.4	6.99	7.1	11.2	9.0		20.0
22.5		1.37	3.1	2.10	3.8	3.08	4.6	4.24	5.4	7.44	7.2	12.0	9.0		22.5
25.0		1.45	3.1	2.22	3.9	3.26	4.7	4.48	5.5	7.87	7.2	12.6	9.1		25.0
27.5		1.52	3.2	2.34	3.9	3.43	4.7	4.71	5.5	8.28	7.3	13.3	9.1		27.5
30.0	0.50	1.60	3.2	2.45	3.9	3.59	4.7	4.94	5.5	8.66	7.3	13.9	9.2	0.50	30.0
32.5		1.66	3.2	2.55	3.9	3.74	4.8	5.15	5.6	9.04	7.3	14.5	9.2		32.5
35.0		1.73	3.2	2.66	4.0	3.89	4.8	5.35	5.6	9.40	7.4	15.1	9.2		35.0
37.5		1.80	3.2	2.76	4.0	4.04	4.8	5.55	5.6	9.74	7.4	15.6	9.3		37.5
40.0		1.86	3.2	2.85	4.0	4.18	4.8	5.74	5.6	10.1	7.4	16.2	9.3		40.0
42.5	0.50	1.92	3.2	2.94	4.0	4.31	4.8	5.93	5.6	10.4	7.4	16.7	9.3	0.50	42.5
45.0		1.98	3.3	3.04	4.0	4.45	4.8	6.11	5.7	10.7	7.4	17.2	9.4		45.0
47.5		2.04	3.3	3.12	4.0	4.58	4.9	6.29	5.7	11.0	7.5	17.7	9.4		47.5
50.0		2.09	3.3	3.21	4.0	4.70	4.9	6.46	5.7	11.3	7.5	18.2	9.4		50.0
52.5		2.15	3.3	3.29	4.1	4.82	4.9	6.63	5.7	11.6	7.5	18.7	9.4		52.5
55.0	1.00	2.20	3.3	3.38	4.1	4.94	4.9	6.79	5.7	11.9	7.5	19.1	9.4	1.00	55.0
57.5		2.25	3.3	3.46	4.1	5.06	4.9	6.95	5.7	12.2	7.5	19.6	9.5		57.5
60.0		2.30	3.3	3.53	4.1	5.17	4.9	7.11	5.8	12.4	7.5	20.0	9.5		60.0
62.5		2.36	3.3	3.61	4.1	5.29	4.9	7.26	5.8	12.7	7.6	20.4	9.5		62.5
65.0		2.40	3.3	3.69	4.1	5.40	5.0	7.41	5.8	13.0	7.6	20.8	9.5		65.0
67.5	1.00	2.45	3.3	3.76	4.1	5.50	5.0	7.56	5.8	13.3	7.6	21.3	9.5	1.00	67.5
70.0		2.50	3.3	3.83	4.1	5.61	5.0	7.71	5.8	13.6	7.6	21.7	9.5		70.0
72.5		2.55	3.4	3.90	4.1	5.71	5.0	7.85	5.8	13.8	7.6	22.1	9.5		72.5
75.0		2.59	3.4	3.97	4.1	5.82	5.0	7.99	5.8	14.0	7.6	22.4	9.6		75.0
77.5		2.64	3.4	4.04	4.1	5.92	5.0	8.13	5.8	14.2	7.6	22.8	9.6		77.5

Table C4.12 Flow of water at 75°C in black steel pipes — *continued*

**MEDIUM GRADE STEEL**  
**WATER AT 75°C**

$\Delta p_i$	$v$	65 mm		80 mm		90 mm		100 mm		125 mm		150 mm		$v$	$\Delta p_i$
		$M$	$l_e$	$M$	$l_e$	$M$	$l_e$	$M$	$l_e$	$M$	$l_e$	$M$	$l_e$		
80.0		2.68	3.4	4.11	4.1	6.02	5.0	8.26	5.8	14.5	7.6	23.2	9.6		80.0
82.5		2.73	3.4	4.18	4.1	6.11	5.0	8.40	5.8	14.7	7.6	23.6	9.6		82.5
85.0		2.77	3.4	4.24	4.1	6.21	5.0	8.53	5.8	14.9	7.6	24.0	9.6		85.0
87.5		2.81	3.4	4.31	4.2	6.30	5.0	8.66	5.8	15.2	7.7	24.3	9.6		87.5
90.0		2.85	3.4	4.37	4.2	6.40	5.0	8.79	5.9	15.4	7.7	24.7	9.6		90.0
92.5		2.90	3.4	4.44	4.2	6.49	5.0	8.91	5.9	15.6	7.7	25.0	9.6		92.5
95.0		2.94	3.4	4.50	4.2	6.58	5.0	9.04	5.9	15.8	7.7	25.4	9.6		95.0
97.5		2.98	3.4	4.56	4.2	6.67	5.0	9.16	5.9	16.0	7.7	25.7	9.6		97.5
100.0		3.02	3.4	4.62	4.2	6.76	5.0	9.28	5.9	16.3	7.7	26.1	9.6	1.5	100.0
120.0		3.32	3.4	5.08	4.2	7.43	5.1	10.2	5.9	17.9	7.8	28.6	9.7		120.0
140.0	1.0	3.60	3.5	5.51	4.2	8.05	5.1	11.1	6.0	19.3	7.8	31.0	9.8		140.0
160.0		3.86	3.5	5.90	4.3	8.63	5.1	11.8	6.0	20.7	7.8	33.2	9.8		160.0
180.0		4.10	3.5	6.27	4.3	9.17	5.2	12.6	6.0	22.0	7.8	35.3	9.8	2.0	180.0
200.0		4.33	3.5	6.63	4.3	9.69	5.2	13.3	6.0	23.2	7.9	37.2	9.8		200.0
220.0		4.55	3.5	6.96	4.3	10.2	5.2	14.0	6.0	24.4	7.9	39.1	9.9		220.0
240.0		4.76	3.5	7.28	4.3	10.6	5.2	14.6	6.1	25.5	7.9	40.9	9.9		240.0
260.0		4.96	3.6	7.59	4.4	11.1	5.2	15.2	6.1	26.6	7.9	42.6	9.9		260.0
280.0		5.16	3.6	7.88	4.4	11.5	5.2	15.8	6.1	27.6	8.0	44.2	9.9		280.0
300.0	1.5	5.34	3.6	8.17	4.4	11.9	5.2	16.4	6.1	28.6	8.0	45.8	10.0		300.0
320.0		5.52	3.6	8.45	4.4	12.3	5.2	16.9	6.1	29.6	8.0	47.4	10.0		320.0
340.0		5.70	3.6	8.71	4.4	12.7	5.3	17.5	6.1	30.5	8.0	48.8	10.0		340.0
360.0		5.87	3.6	8.97	4.4	13.1	5.3	18.0	6.1	31.4	8.0	50.3	10.0		360.0
380.0		6.06	3.6	9.23	4.4	13.5	5.3	18.5	6.1	32.3	8.0	51.7	10.0		380.0
400.0		6.20	3.6	9.47	4.4	13.8	5.3	19.0	6.1	33.2	8.0	53.1	10.0		400.0
420.0		6.36	3.6	9.71	4.4	14.2	5.3	19.5	6.2	34.0	8.0	54.4	10.0	3.0	420.0
440.0		6.51	3.6	9.95	4.4	14.5	5.3	19.9	6.2	34.8	8.0	55.7	10.0		440.0
460.0		6.66	3.6	10.2	4.4	14.9	5.3	20.4	6.2	35.6	8.0	57.0	10.0		460.0
480.0		6.81	3.6	10.4	4.4	15.2	5.3	20.8	6.2	36.3	8.0	58.2	10.0		480.0
500.0		6.95	3.6	10.6	4.4	15.5	5.3	21.3	6.2	37.1	8.0	59.4	10.0		500.0
520.0	2.0	7.09	3.6	10.8	4.4	15.8	5.3	21.7	6.2	37.9	8.0	60.6	10.1		520.0
540.0		7.23	3.6	11.0	4.4	16.1	5.3	22.1	6.2	38.6	8.1	61.8	10.1		540.0
560.0		7.37	3.6	11.3	4.4	16.4	5.3	22.5	6.2	39.4	8.1	63.0	10.1		560.0
580.0		7.50	3.6	11.5	4.4	16.7	5.3	22.9	6.2	40.1	8.1	64.1	10.1		580.0
600.0		7.63	3.6	11.7	4.4	17.0	5.3	23.3	6.2	40.8	8.1	65.2	10.1		600.0
620.0		7.76	3.6	11.9	4.5	17.3	5.3	23.7	6.2	41.5	8.1	66.3	10.1		620.0
640.0		7.89	3.6	12.1	4.5	17.6	5.3	24.1	6.2	42.1	8.1	67.4	10.1		640.0
660.0		8.02	3.6	12.2	4.5	17.9	5.4	24.5	6.2	42.8	8.1	68.5	10.1		660.0
680.0		8.14	3.6	12.4	4.5	18.2	5.4	24.9	6.2	43.5	8.1	69.5	10.1		680.0
700.0		8.26	3.6	12.6	4.5	18.4	5.4	25.3	6.2	44.1	8.1	70.5	10.1		700.0
720.0		8.38	3.6	12.8	4.5	18.7	5.4	25.6	6.2	44.7	8.1	71.6	10.1		720.0
740.0		8.50	3.6	13.0	4.5	19.0	5.4	26.0	6.2	45.4	8.1	72.6	10.1		740.0
760.0		8.61	3.7	13.2	4.5	19.2	5.4	26.3	6.2	46.0	8.1	73.5	10.1	4.0	760.0
780.0		8.73	3.7	13.3	4.5	19.5	5.4	26.7	6.2	46.6	8.1				780.0
800.0		8.84	3.7	13.6	4.5	19.7	5.4	27.0	6.2	47.2	8.1				800.0
820.0		8.96	3.7	13.7	4.5	20.0	5.4	27.4	6.2	47.8	8.1				820.0
840.0		9.07	3.7	13.8	4.5	20.2	5.4	27.7	6.2	48.4	8.1				840.0
860.0		9.18	3.7	14.0	4.5	20.4	5.4	28.0	6.2	49.0	8.1				860.0
880.0		9.29	3.7	14.1	4.5	20.7	5.4	28.4	6.2	49.5	8.1				880.0
900.0		9.39	3.7	14.3	4.5	20.9	5.4	28.7	6.2	50.1	8.1				900.0
920.0		9.50	3.7	14.5	4.5	21.2	5.4	29.0	6.2	50.7	8.1				920.0
940.0		9.60	3.7	14.7	4.5	21.4	5.4	29.3	6.2	51.2	8.1				940.0
960.0		9.71	3.7	14.8	4.5	21.6	5.4	29.7	6.2						960.0
980.0		9.81	3.7	15.0	4.5	21.9	5.4	30.0	6.3						980.0
1 000.0		9.91	3.7	15.1	4.5	22.1	5.4	30.3	6.3						1 000.0
1 100.0	3.0	10.4	3.7	15.9	4.5	23.2	5.4	31.8	6.3						1 100.0
1 200.0		10.9	3.7	16.6	4.5	24.2	5.4	33.2	6.3						1 200.0
1 300.0		11.3	3.7	17.3	4.5	25.2	5.4								1 300.0
1 400.0		11.8	3.7	18.0	4.5	26.2	5.4								1 400.0
1 500.0		12.2	3.7	18.6	4.5										1 500.0
1 600.0		12.6	3.7	19.2	4.5										1 600.0
1 700.0		13.0	3.7	19.8	4.5										1 700.0
1 800.0		13.4	3.7												1 800.0
1 900.0		13.7	3.7												1 900.0

**TYPICAL RADIATOR PIPEWORK SIZING (SAMPLE CALCULATIONS)**

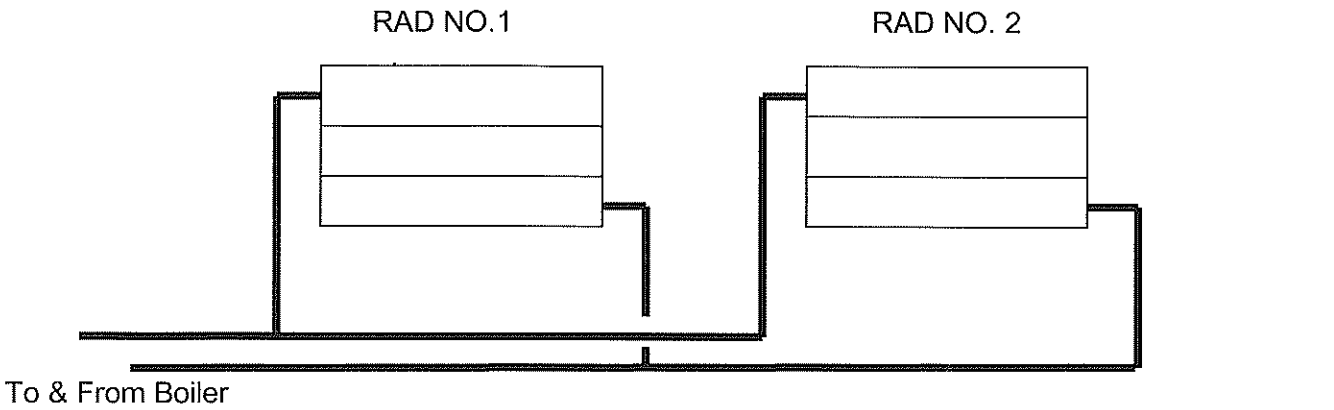
CONDITIONS

ROOM HEAT LOSS = 5 kW

2 NO. RADIATORS = AT 2.5 kW EACH

FLOW TEMPERATURE = 82°C

RETURN TEMPERATURE = 71°C



Rad No. 1 & 2 Output: kW = kg/s x 4.2 x Δt °C.

2.5 = kg/s x 4.2 x (82 – 71)

=> m = 2.5 / 46.2

=> m = 0.0541 kg/s

From Charts,

Pipe diameter = **15 mm**

Pressure Drop = 80 Pa/m

Equivalent length = 0.5 → 0.3

Velocity = less than 0.3 m/s

*Pipe serving the 2 No. Rads*

Load = 5.0 kW

5.0 = kg/s x 4.2 x (82 – 71)

=> m = 5.0 / 46.2

$$\Rightarrow m = 0.108 \text{ kg/s}$$

From Charts,

Pipe diameter = **20 mm**

Pressure Drop = 65 Pa/m

Equivalent length = 0.7

Velocity = just above 0.3 m/s

**EXAMPLE 2**

Determine a suitable pipe size for L.P.H.W. medium grade steel pipe for a flow rate of 1.0 kg/s.

Answer:

A **40 mm** pipe gives a flow rate of 1.0 kg/s with a pressure loss of ~~150~~ <sup>140 Pa/m</sup> Pa/m and velocity of about 0.9 m/s.

**EXAMPLE 3**

Choose a pipe diameter for a heating system (L.P.H.W.) with a heat output of 32 kW.

Answer: First find the mass flow rate of water required.

$$H = m \cdot C_p \cdot \delta t$$

$$m = \frac{H}{C_p \times \delta t}$$

- where
- m = mass flow rate of water (kg/s)
  - H = total heat loss or heat load (kW)
  - C<sub>p</sub> = Specific heat capacity of water (4.2 kJ/kg deg. C)
  - δt = temperature difference between water flow and return (80 - 70°C) i.e. 10deg.C.

$$m = \frac{32}{4.2 \times 10} = \frac{32}{42} = 0.76 \text{ kg/s}$$

## Project No. 2: Radiator Sizing/Pipe Work Sizing Question

### Part 1

1. Size the pipework for the heating system shown below.

State any assumptions

The total lengths of the section are:

SECTION	LENGTH F&R m
1	16
2	6
3	6

