

**CALCULATION SHEET FOR FIRE PROTECTION SYSTEM  
 SPRINKLER PUMP  
 LOCATION : BASEMENT 2**

- \* Sprinkler system design to NFPA13 and TCVN 7336-2003  
 For basement carpark , According TCVN 7336 :2003 use category Ordinary Hazard Group II, Area of sprinkler operation shall be 240 m<sup>2</sup> with density design 0.24 l/s.m<sup>2</sup> .  
 Capacity of sprinkler system shall be 0.24 l/s.m<sup>2</sup> x 240 m<sup>2</sup> = 57.6 l/s
- \* Fire hydrant system design to NFPA 13 and TCVN 7336-2003 : the minimum flow rate for the hydraulically most remote standpipe shall be 5 l/s x 2 = 10 l/s
- \* Capacity of fire pump at basement : 57,6 l/s + 10 l/s = 67,6 l/s ~ 68 l/s
- \* Static head of pump :  
 The most unfavourable area is choosed at B1M ( Grid line X-XB/ 18-21): refer Figure 1

<p><b>FORMULAS: (FOLLOWS NFPA 13)</b></p> <p>1. The calculated water expense Q, gpm, going through sprinkler shall be calculated as following formula:  <math display="block">Q = K \cdot \sqrt{Pt} \quad (\text{gpm})</math></p> <p><u>Where:</u>                  + K is water expense coefficient through sprinkler (K=11.2)                  + Pt is free pressure before sprinkler (psi)</p> <p>2. Friction loss formula: Pipe friction losses shall be deter-mined on the basis of the Hazen - Williams formula, as follows:  <math display="block">p = \frac{4.52 Q^{1.85}}{C^{1.85} d^{4.87}} \quad (\text{psi})</math></p> <p><u>Where:</u>                  + p is frictional resistance in psi per foot of pipe.                  + Q is flow in gpm.                  + C is friction loss coefficient. (follows Table 8-4.4.5 - Chapte 8)                  + d is actual internal diameter of pipe in inches.</p> $Q = K \cdot \sqrt{Pt}$	<p><u>For SI units:</u>                  1feet=0.3048m                  1 l/s =15.85 gpm</p> <p>1feet elevation diferences equivalent to 0.3048*1.42=0.433 (psi)</p> <p><u>Of which:</u></p> <p>Pt= 7.9                  C= 100                  C= 120</p> <p style="text-align: right;">(Black steel - dry systems)                  (Black steel - wet systems)</p>
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**HYDRAULIC CALCULATION - SPRINKLER PUMP - LEVEL B2 (FOLLOW DWG DIAGRAM CALCULATION - No.1, Figure 1,Figure 4)**

Node	Flow-(gpm)	Pipe size (inch)	Fitting & divide	Pipe equiv Length( feet)	frictional (p)	Required (psi)	Notes
1	q	31.48	1.1/4 90° Elbow	lgth 3.70	0.07	Pt 7.9	q = 31.48  Elevation Differences +3.0ft
	Q			fk 4.00		Pe 1.30	
				Tck 7.70		Pf 0.50	
2	q		1.1/4	lgth 6.89	0.07	Pt 9.70	
	Q	31.48		fk		Pe	
				Tck 6.89		Pf 0.45	
4-left	q		1.1/4	lgth		Pt 10.15	No4-left Q= 31.48 @ 10.15
	Q	31.48		fk		Pe	
				Tck		Pf	
3	q	31.48	1.1/4 Tee	lgth 0.70	0.07	Pt 7.9	q = 31.48
	Q			fk 5.00		Pe	
				Tck 5.70		Pf 0.37	
4-front	q		1.1/4	lgth		Pt 8.27	No4-front Q= 31.48 @ 8.27
	Q	31.48		fk		Pe	
				Tck		Pf	

Node	Flow-(gpm)	Pipe size (inch)	Fitting & divide	Pipe equiv Length( feet)	frictional (p)	Required (psi)	Notes	
Balancing at No4								
No4-left = 31.48 No4-front = 34.87 No4 = 66.35      gpm @ 10.15 psi								
6-left	q	66.35	1.1/2	lgth 6.89	0.12	Pt 10.15	No6-left Q= 66.35 @ 11.01	
	Q			fk		Pe		
				Tck 6.89		Pf 0.86		
5	q	31.48	1.1/4	lgth 3.70	0.07	Pt 7.9	q = 31.48	
	Q			90° Elbow		fk 2.00		Pe 1.30
				Tee		fk 5.00		
						Tck 10.70		Pf 0.70
6-front	q	31.48	1.1/4	lgth		Pt 9.89	No6-front Q= 31.48 @ 9.89	
	Q			fk		Pe		
				Tck		Pf		
Balancing at No6								
No6-left = 66.35 No6-front = 33.20 No6 = 99.55      gpm @ 11.01 psi								
7-left	q	99.55	1.1/2	lgth 6.89	0.26	Pt 11.01	No7-left Q= 99.55 @ 12.82	
	Q			fk		Pe		
				Tck 6.89		Pf 1.82		
7-front	q	31.48	1	lgth		Pt 8.27	No7-front=No4-front Q= 31.48 @ 8.27	
	Q			fk		Pe		
				Tck		Pf		
Balancing at No7								
No7-left = 99.55 No7-front = 39.20 No7 = 138.75      gpm @ 12.82 psi								
8-left	q	138.75	2	lgth 6.89	0.16	Pt 12.82	No8-left Q= 138.75 @ 13.90	
	Q			fk		Pe		
				Tck 6.89		Pf 1.07		
8-front	q	31.48	1.1/4	lgth		Pt 9.89	No8-front=No6-front Q= 31.48 @ 9.89	
	Q			fk		Pe		
				Tck		Pf		
Balancing at No8								
No8-left = 138.75 No8-front = 37.31 No8 = 176.05      gpm @ 13.90 psi								
12-left	q	176.05	2	lgth 4.59	0.24	Pt 13.90	No12-left Q= 176.05 @ 17.43	
	Q			Tee		fk 10.00		Pe
						Tck 14.59		Pf 3.53
9	q	31.48	1.1/4	lgth 10.17	0.07	Pt 7.9	q = 31.48	
	Q			Tee		fk 4.00		Pe
						Tck 14.17		Pf 0.92
10-right	q	31.48	1.1/2	lgth		Pt 8.82	No10-right Q= 31.48 @ 8.82	
	Q			fk		Pe		
				Tck		Pf		
10-front	q	31.48	1.1/4	lgth		Pt 9.89	No10-front=No6-front Q= 31.48 @ 9.89	
	Q			fk		Pe		
				Tck		Pf		

Node	Flow-(gpm)	Pipe size (inch)	Fitting & divide	Pipe equiv Length( feet)	frictional (p)	Required (psi)	Notes
Balancing at No10							
No10-right = 33.34 No10-front = 31.48 No10 = 64.82 gpm @ 9.89 psi							
11-right	q	64.82	1.1/2	lgth 6.89	0.12	Pt 9.89	No11-right Q= 64.82 @ 10.72
	Q			fk		Pe	
				Tck 6.89		Pf 0.82	
11-front	q	31.48	1.1/4	lgth		Pt 8.27	No11-front=No4-front Q= 31.48 @ 8.27
	Q			fk		Pe	
				Tck		Pf	
Balancing at No11							
No11-right = 64.82 No11-front = 35.83 No11 = 100.65 gpm @ 10.72 psi							
12-right	q	100.65	1.1/2	lgth 2.30	0.27	Pt 10.72	No12-right Q= 100.65 @ 13.49
	Q			Tee fk 8.00		Pe	
				Tck 10.30		Pf 2.77	
Balancing at No12							
No12-left = 176.05 No12-right = 114.40 No12 = 290.45 gpm @ 17.43 psi							
13-above	q	290.45	2.1/2	lgth 1.00	0.17	Pt 17.43	No13-above Q= 290.45 @ 19.07
	Q			90° Elbow fk 6.00		Pe 0.43	
				Tck 7.00		Pf 1.21	
16-front	q	290.45	2.1/2	lgth 13.78	0.17	Pt 19.07	No16-front Q= 290.45 @ 21.47
	Q			fk		Pe	
				Tck 13.78		Pf 2.39	
13'	q	31.48	1.1/4	lgth 7.59	0.07	Pt 7.9	q = 31.48
	Q			90° Elbow fk 2.00		Pe	
				Tck 9.59		Pf 0.62	
14'-right	q	31.48	1.1/4	lgth		Pt 8.52	No14'-right Q= 31.48 @ 8.52
	Q			fk		Pe	
				Tck		Pf	
14'-front	q	31.48	1.1/4	lgth		Pt 9.89	No14'-front=No6-front Q= 31.48 @ 9.89
	Q			fk		Pe	
				Tck		Pf	
Balancing at No14'							
No14'-front = 31.48 No14'-right = 33.92 No14' = 65.40 gpm @ 9.89 psi							
14-right	q	65.40	1.1/2	lgth 6.89	0.12	Pt 9.89	No14-right Q= 65.40 @ 10.73
	Q			fk		Pe	
				Tck 6.89		Pf 0.84	
14-front	q	31.48	1.1/4	lgth		Pt 8.27	No14-front=No4-front Q= 31.48 @ 8.27
	Q			fk		Pe	
				Tck		Pf	
Balancing at No14							
No14-right= 65.40 No14-front = 35.86 No14 = 101.25 gpm @ 10.73 psi							
15-right	q	101.25	1.1/2	lgth 2.30	0.27	Pt 10.73	No15-right Q= 101.25 @ 13.53
	Q			Tee fk 8.00		Pe	
				Tck 10.30		Pf 2.80	

Node	Flow-(gpm)		Pipe size (inch)	Fitting & divide	Pipe equiv Length( feet)	frictional (p)	Required (psi)	Notes
15-left	q		2		lgth		Pt 17.43	No15-left=No12-left Q= 176.05 @ 17.43
	Q	176.05			fk		Pe	
					Tck		Pf	
Balancing at No15								
No15-left = 176.05 No15-right = 114.89 No15 = 290.94 gpm @ 17.43 psi								
16-above	q		2.1/2		lgth 1.00	0.17	Pt 17.43	No16-above Q= 290.94 @ 20.12
	Q	290.94		Tee	fk 12.00		Pe 0.43	
					Tck 13.00		Pf 2.26	
Balancing at No16								
No16-front = 290.45 No16-above= 300.50 No16 = 590.95 gpm @ 21.47 psi								
17-front	q		3		lgth 13.78	0.30	Pt 21.47	No17-front Q= 590.95 @ 25.53
	Q	590.95			fk		Pe	
					Tck 13.78		Pf 4.07	
17-above	q		2.1/2		lgth		Pt 20.12	No17-above=No16- Q= 290.94 @ 20.12
	Q	290.94			fk		Pe	
					Tck		Pf	
Balancing at No17								
No17-front = 590.95 No17-above= 327.74 No17 = 918.69 gpm @ 25.53 psi								
18	q		4		lgth 23.27	0.19	Pt 25.53	No18 Q= 918.69 @ 30.31
	Q	918.69			fk		Pe 0.43	
					Tck 23.27		Pf 4.34	
19-right	q		6	Tee	lgth 20.40	0.01	Pt 30.31	No19-right Q= 459.35 @ 30.70
	Q	459.35			fk 30.00		Pe	
					Tck 50.40		Pf 0.39	
19-left	q		6		lgth 384.48	0.01	Pt 30.31	No19-left Q= 459.35 @ 35.43
	Q	459.35		Tee	fk 60.00		Pe	
				90° Elbow	fk 210.00			
					Tck 654.48		Pf 5.12	
Balancing at No 19								
$K_r = Q_r / (P_r^{0.5}) = 82.90$ $K_l = Q_l / (P_l^{0.5}) = 77.17$ $P_{that} = (\sum(Q_l + Q_r) / \sum(K_l + K_r))^{0.5} = 32.94$ $Q_{19r-that} = K_r * P_{that}^{0.5} = 475.78$ $Q_{19l-that} = K_l * P_{that}^{0.5} = 442.92$ No19-right-that = 475.78 No19-left-that = 442.92 No19 = 918.69 gpm @ 32.94 psi								
19'	q		6		lgth 48.30	0.03	Pt 32.94	
	Q	918.69			fk 60.00		Pe	
					Tck 108.30		Pf 3.13	
20	q		6	90° Elbow	lgth 40.71	0.03	Pt 36.07	No20 Q= 918.69 @ 53.40
	Q	918.69		AV	fk 20.00		Pe 13.78	
				GV	fk 9.00			
					Tck 125.71		Pf 3.54	
21	q		6		lgth 18.29	0.03	Pt 53.40	No21 Q= 918.69
	Q	918.69		Tee	fk 30.00		Pe -3.23	
				90° Elbow	fk 42.00			
Balancing at No 21								
No21-front = 918.69 No21-above= 918.69 No21 = 1837.38 gpm @ 53.40 psi								
Balancing at No 20								
No20-front = 918.69 No20-above= 918.69 No20 = 1837.38 gpm @ 53.40 psi								
Balancing at No 19'								
No19'-front = 918.69 No19'-above= 918.69 No19' = 1837.38 gpm @ 32.94 psi								

Node	Flow-(gpm)	Pipe size (inch)	Fitting & divide	Pipe equiv Length( feet)	frictional (p)	Required (psi)	Notes
				Tck 90.29		Pf 2.55	@ 52.71
A	q	79.25	2.1/2	lgth 76.81	0.02	Pt 36.74	+30m hose reel + Elevation Differences-6.56ft
	Q			Tee fk 12.00		Pe 1.35	
				90° Elbow fk 6.00			
				GV fk 1.00			
				Tck 95.81		Pf 1.50	
B	q	79.25	3	lgth 18.93	0.007	Pt 39.59	
	Q			fk		Pe	
				Tck 18.93		Pf 0.14	
D-right	q	79.25	3	lgth		Pt 39.73	NoD-right Q= 79.25 @ 39.73
	Q			fk		Pe	
				Tck		Pf	
C	q	79.25	2.1/2	lgth 15.73	0.02	Pt 36.74	+30m hose reel + Elevation Differences-6.56ft
	Q			Tee fk 12.00		Pe 1.35	
				90° Elbow fk 6.00			
				GV fk 1.00			
				Tck 34.73		Pf 0.55	
D-front	q	79.25	2.1/2	lgth		Pt 38.63	NoD-front Q= 79.25 @ 38.63
	Q			fk		Pe	
				Tck		Pf	
Balancing at No D							
NoD-right = 79.25 NoD-front = 80.37 NoD = 159.62 gpm @ 39.73 psi							
E	q	159.62	4	lgth 24.93	0.007	Pt 39.73	
	Q			Tee fk 20.00		Pe	
				Tck 44.93		Pf 0.33	
F	q	159.62	4	lgth 39.83	0.01	Pt 40.06	Elevation Differences +31.83 ft
	Q			Tee fk 20.00		Pe 13.78	
				90° Elbow fk 30.00			
				AV fk 13.00			
				GV fk 2.00			
				Tck 104.83		Pf 0.83	
G-front	q	159.62	4	lgth 17.09	0.01	Pt 54.67	NoG-front Q= 159.62 @ 52.25
	Q			Tee fk 20.00		Pe -2.70	
				90° Elbow fk 20.00			
				Tck 37.09		Pf 0.27	
G-right	q	459.35	8	lgth 2.00	0.002	Pt 52.71	NoG-right Q= 459.35 @ 52.72
	Q			fk		Pe	
				Tck 2.00		Pf 0.00	
Balancing at No G							
NoG-front = 160.33 NoG-right= 459.35 NoG = 619.68 gpm @ 52.72 psi							
22-left	q	619.68	8	lgth 1070.64	0.004	Pt 52.72	No22-left Q= 619.68 @ 58.63
	Q			90° Elbow fk 378.00		Pe	
				Tck 1448.64		Pf 5.91	
22-right	q	459.35	8	lgth 1815.25	0.002	Pt 52.71	No22-left Q= 459.35 @ 58.36
	Q			90° Elbow fk 594.00		Pe	
				Tck 2409.25		Pf 5.65	
$K_l = Q_l / (P_l^{0.5}) = 80.93$ $K_r = Q_r / (P_r^{0.5}) = 60.13$ $P_{that} = (\sum(Q_l + Q_r) / \sum(K_l + K_r))^2 = 58.51$ $Q_{22l-that} = K_l * P_{that}^{0.5} = 619.08$ $Q_{22r-that} = K_r * P_{that}^{0.5} = 459.95$							
Balancing at No 22							

Node	Flow-(gpm)	Pipe size (inch)	Fitting & divide	Pipe equiv Length( feet)	frictional (p)	Required (psi)	Notes
No22-left-that = 619.08 No22-right-that = 459.95 No22 = 1079.03 gpm @ 58.51 psi							
23-front	q	1079.03	8		lgth 174.87	0.011	Pt 58.51
	Q			Tee	fk 35.00		Pe 8.22
				90° Elbow	fk 72.00		
				GV	fk 4.00		
				Tck	285.87		Pf 3.25
23	q	1079.03	10		lgth 4.27	0.004	Pt 69.99
	Q			Tee	fk 50.00		Pe
				Tck	54.27		Pf 0.21
24	q	1079.03	8		lgth 17.88	0.011	Pt 70.20
	Q			90° Elbow	fk 18.00		Pe
				GV	fk 4.00		
				CV	fk 45.00		
				Tck	84.88		Pf 0.97
25	q	1079.03	10		lgth 20.18	0.004	Pt 71.17
	Q			90° Elbow	fk 22.00		Pe
				GV	fk 5.00		
				Y - strainer	fk 180.00		
				Tck	227.18		Pf 0.89
26	q	1079.03	10		lgth		Pt 72.06
	Q			fk			Pe
				Tck			Pf

Elevation Differences+18.98ft

+ Sprinkler pump flow rate: **1079.03** (gpm) = **67.98** (l/s)  
 + The static head at sprinkler pump : **72.06** x 1.2 = **86.5** (psi) = **6.1** (Bar)  
**+ Sprinkler pump capacity: 68.0 l/s @ 6 Bar**