This handout is intended to provide a few sample questions to help prepare for UFM tests. Especially mathematical questions that participants have the most difficulty with. Please study these carefully and do not take the UFM4 test until you have a good understanding of the mathematical questions shown here. Those taking UFM 4 tests must have a basic understanding of friction loss with respect to pipe size and lengths, and how a fire pumps impact pressures on a system such as a remote pump house serving a site loop. You are installing life-safety systems. The ability to verify proper system design and installation is critical for the protection of property and lives of those using these systems.

Other questions on UFM tests relate to any material found in NFPA 24. Questions on UFM tests will include depth of burry for piping, valves, fire hydrants, fire department connections, backflow requirements (by NFPA 24 if any), flushing of fire lines, equipment needed to measure the flow and velocity of water during flushing, flow rates based on size of pipe, how to use a pitot meter, loading of pipe, inspection of fittings during pressure testing, amounts of leakage, and much more. You must have a good understanding of the above items to pass the assessments.

The following table is taken from NFPA 24 and is used for questions 1 – 4 on calculating the area of thrust blocks.

Table A.10.8.2(a) Thrust at Fittings at 100 psi (6.9 bar) Water Pressure for Ductile Iron and PVC Pipe

Nominal Pipe Diameter (in.)	Total Pounds					
	Dead End	90-Degree Bend	45-Degree Bend	22 ½-Degree Bend	11 ¼-Degree Bend	5 ⅛-Degree Bend
4	1,810	2,559	1,385	706	355	162
6	3,739	5,288	2,862	1,459	733	334
8	6,433	9,097	4,923	2,510	1,261	575
10	9,677	13,685	7,406	3,776	1,897	865
12	13,685	19,353	10,474	5,340	2,683	1,224
14	18,385	26,001	14,072	7,174	3,604	1,644
16	23,779	33,628	18,199	9,278	4,661	2,126
18	29,865	42,235	22,858	11,653	5,855	2,670
20	36,644	51,822	28,046	14,298	7,183	3,277
24	52,279	73,934	40,013	20,398	10,249	4,675
30	80,425	113,738	61,554	31,380	15,766	7,191
36	115,209	162,931	88,177	44,952	22,585	10,302
42	155,528	219,950	119,036	60,684	30,489	13,907
48	202,683	286,637	155,127	79,083	39,733	18,124

Notes:
1. For SI units, 1 lb = 0.454 kg.
2. To determine thrust at pressure other than 100 psi (6.9 bar), multiply the thrust obtained in the table by the ratio of the pressure to 100 psi (6.9 bar). For example, the thrust on a 12-in., 90-degree bend at 125 psi (8.6 bar) is 19,353 × 125/100 = 24,191 lb.

Sample Questions - CSA UFM Assessments

Question 1:
Using the following information calculate the required thrust block area against undisturbed soil.
Pipe Diameter = 10"
Water pressure = 100 psi
Fitting = 45-Degree bend
Bearing strength of soil = 3000lb/ft2
Safety Factor = 1.5

Area = (Thrust Force) x (Safety Factor) / (Soil bearing strength)
Area = (7,406 lb from table) x (1.5 safety factor from above) / (3,000 lb/ft2 from above)
Area = 3.703 ft2 rounded to **3.7 square feet**

Question 2:
Using the following information calculate the required thrust block area against undisturbed soil.
Pipe Diameter = 10"
Water pressure = 100 psi
Fitting = Dead End
Bearing strength of soil = 3000lb/ft2
Safety Factor = 1.5

Area = (Thrust Force) x (Safety Factor) / (Soil bearing strength)
Area = (9,677 lb from table) x (1.5 safety factor from above) / (3,000 lb/ft2 from above)
Area = 4.8385 ft2 rounded to **4.8 square feet**

Question 3:
Using the following information calculate the required thrust block area against undisturbed soil.
Pipe Diameter = 10"
Water pressure = 80 psi
Fitting = Dead End
Bearing strength of soil = 3000lb/ft2
Safety Factor = 1.5

Note that in this question the water pressure is 80 psi. The table in NFPA 24 gives values when the pressure is equal to 100 psi. If the pressure is above or below 100 psi you have to adjust for this with a ratio of the actual pressure divided by 100 such as n/100 where n=the actual pressure. Footnote #2 of the table shows how this works.

Adjust for corrected force based on pressure: 9,677 lb from table x (80 psi / 100 psi) = corrected psi
9,677 lb x (0.8) = 7,741.6 lb rounded to 7,742 pound (lb) force

Area = (Thrust Force) x (Safety Factor) / (Soil bearing strength)
Area = (7,742 lb force) x (1.5 safety factor from above) / (3,000 lb/ft2 from above)
Area = 3.871 ft2 rounded to **3.9 square feet**

Sample Questions - CSA UFM Assessments

Question 4:
Using the following information calculate the required thrust block area against undisturbed soil.
Pipe Diameter = 8"
Water pressure = 125 psi
Fitting = 45-Degree Bend
Bearing strength of soil = 1500 lb/ft2
Safety Factor = 1.5

Note that in this question the water pressure is 125 psi. The table in NFPA 24 gives values when the pressure is equal to 100 psi. If the pressure is above or below 100 psi you have to adjust for this with a ratio of the actual pressure divided by 100 such as n/100 where n=the actual pressure. Footnote #2 of the table shows how this works.

Adjust for corrected force based on pressure: 4,923 lb from table x (125 psi / 100 psi) = corrected psi
4,923 lb x (1.25) = 6,153.75 lb rounded to 6,154 pound (lb) force

Area = (Thrust Force) x (Safety Factor) / (Soil bearing strength)
Area = (6,154 lb force) x (1.5 safety factor from above) / (1,500 lb/ft2 from above)
Area = 6.154 ft2 rounded to **6.2 square feet**

Question 5: FIRE PUMPS AND PRESSURES
You are installing an underground fire main between a remotely located private fire pump and the buildings sprinkler riser. The civil plans require that you provide a pipe with a pressure rating for the normally anticipated pressure on the system once the sprinkler contractor sizes the pump. The sprinkler contractor will not be installing any pressure control devices.

The normal static city supply pressure to the pump is 40 psi.
The sprinkler contractor is providing a pump rated at 75 psi at 1,000 gpm.
The fire pump will deliver a normal churn pressure (pressure when water is not flowing) of 120%.

What pressure rating of pipe is required between the pump and the building riser?
150 psi
175 psi
200 psi

Answer:
The pump is rated at 75 psi. Churn pressure is the pressure that a fire pump will deliver when it is running and not flowing any water. This pressure will often be around 120% of the rated pressure. Thus, if the pump is rated at 75 psi and has a churn of 120% it will produce a discharge pressure of 90 psi. This is the pressure with 0 psi suction. Now you must add the suction pressure to the pump pressure to get the final discharge pressure. Thus:

Final discharge pressure at churn is (40 psi city pressure) + (90 psi churn pressure) = 130 psi.
The piping running between the pump and the building must be rated at least as high as the city + pump pressure. Therefore, the piping must be rated for at least **150 psi**. The pipe rating must be above the final discharge pressure.

If the city supply was 70 psi and the fire pump was rated at 100 psi with a 120% churn, the following would apply.
(100 psi x 1.2 churn) + (70 psi city pressure) = final discharge
(120 psi churn) + (70 psi city) = 190 psi which would require a minimum 200 psi rated pipe.

Question 6: FRICTION LOSS

A sprinkler system has a hydraulically calculated demand of 250 gpm at 50 psi at the riser. The available flow at the street is 250 gpm at 60 psi. The equivalent length of run (including fittings, valves, etc.) from the street to the riser is 200 ft.

Using the information below, what is the minimum size supply pipe needed to supply this system? Assume that any safety factors have already been included in the riser demand.

Friction loss:
3" = 0.0426 psi/ft
4" = 0.0107 psi/ft

3 inch
4 inch

Answer:

From the information in the question we see that the street pressure is 60 psi and that the riser must have at least 50 psi to work. This tells us that we can not loose more than 10 psi between the street connection and the riser (60 psi – 50 psi = 10 psi). Therefore, we have to select a pipe that will not drop the pressure more than 10 psi over the 200 feet. The best approach is to calculate the friction loss for each pipe size over the 200 feet and see what the smallest pipe size can be without going over 10 psi.

3" pipe (0.0426 psi/ft x 200 ft = 8.52 psi
4" pipe (0.0107 psi/ft x 200 ft = 2.14 psi

We see that the 4 inch pipe only has a pressure loss of 2.14 psi so this pipe results in the least friction loss. However, the question specifically asked <u>what is the minimum size supply pipe needed to supply the system</u>? Because the 3" pipe friction loss is less than 10 psi it will work. **Thus, 3" is the correct answer for minimum size pipe**.

If the question asked which pipe provides for the least amount of friction loss, then the 4" pipe would be correct.

Friction Loss Questions for Underground Fire Mains:

1. A new 6" fire main is being installed to supply a warehouse. Based on the anticipated fire flow demand of the sprinkler system the friction loss will be 0.03 psi/ft (psi per foot). The new section of pipe will be 125' long. What is the friction loss (in psi) within this new section of pipe?

   Answer: A friction loss of 0.03 psi/ft x 125' of pipe results in a total loss of 3.75 psi.

2. If a 200' section of pipe has a total friction loss of 4 psi, what is the friction loss per foot of pipe (psi/ft)?

   Answer: Divide the friction loss by the total length of pipe to get the loss per foot of pipe. 4 psi / 200' = 0.02 psi/ft

3. A fire pump has been installed on a supply pipe between the street tap and the building. The fire flow at the street has a static pressure of 70 psi and a residual flow of 55 psi at 1,000 gpm. The sprinkler contractor has selected a fire pump rated at 90 psi at 1,000 gpm. No pressure reducing valves have been provided. Assuming the sprinkler system is flowing 1,000 gpm, what is the discharge pressure at the pump?

Answer: Pumps boost pressure. In this question (typical of UFM4 questions) the flows are consistent and the question is based on flowing water or residual pressures. As long as the flows are the same you simply add the pressures of 55 psi suction + 90 psi pump to obtain a discharge of 145 psi.

a. Using the information in the question above calculate the following: The fire pump develops a churn pressure of 120% of the rated pressure. What is the discharge pressure of the pump at churn during the weekly automatic pump test?

   Answer: The churn pressure of the pump by itself is 90 psi x 1.20 (or 120%) = 108 psi. The question asks for the discharge pressure during the weekly automatic pump test. This indicates that the system is open to the street pressure which provides a static pressure of 70 psi. Thus, You have to add the static pressure of 70 psi to the pump churn pressure of 108 psi to get 178 psi discharge pressure.

b. The civil engineer did not specify a pressure rating for the pipe as he/she did not know what size pump the sprinkler contractor was going to select. Using the information above, what is the required minimum pressure rating of the underground pipe between the pump and the building? Select the appropriate option below.
   1.) 100 psi 2.) 150 psi 3.) 200 psi

   Answer to 3b: Based on the answer from question 3a we identified that the pump churn during the weekly testing will be 178 psi, which is above 150 psi. Therefore, the pipe must be rated for 200 psi. (This churn pressure of 178 can also create issues for the sprinkler contractor as many of his fittings are generally only rated for 175 psi. This issue is not addressed here).