STUDY AND TEST MATERIAL FOR THE

UFM2 and UFM4

ASSESSMENTS

(Underground Fire Mains On-Site and Business Cert. Holder)
September 17, 2010
Revised 4-8-11

This document contains sample questions to help participants study for the UFM2 and UFM4 assessments.

If you intend to take this booklet into the test, make sure it is bound in a binder or stapled. You will not be allowed to take this material into the test center if it is not bound.

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[Revision 3-29-11: corrected time for UFM4 from 1.5 hours to 2 hours] [Revision 4-8-11: added some more sample questions at end]

About the Assessment:

Assessment Abbreviation: UFM2

Number of Questions: 43

Amount of Time for Test: 1-hour (60 minutes)

Assessment Abbreviation: UFM4

Number of Questions: 62

Amount of Time for Test: 2-hour (120 minutes)

Exam format: Open book (bring your own books); calculators will be available, writing tablet or paper will be provided for calculations. Any books or exam documents brought into exam must be bound as no loose papers are allowed.

Passing Score: 80%

Cell Phones: Do not bring cell phones, pagers, or radios into the test center.

Codes / Materials Used for Exam and Editions:

- 2010 NFPA 24
- There may be a couple questions related to Occupational Safety and Health Act related to excavating
- There are questions requiring mathematic calculations to determine area of thrust blocks or pressure ratings. Example questions and how to calculate are in this document.

General Assessment Information:

About the Questions: Questions are randomly selected from respective topics within a larger database. Answer choices are randomly mixed, meaning that choice "B" will not always be in position "B".

Exam Format: Questions are computer based and will be delivered one at a time. You will have the opportunity to go back and review all questions. You can also "check" a box within each question which will flag it for later review. During the review, checked questions will be marked for easier identification. See the document on "Screen Shots" under the "Test Info" link on our web site.

Time Clock: Most assessments will have a count-down timer displayed on the screen. It may appear as if this timer is fluctuating between questions (gaining time on one question and loosing time on the next question). This is normal. The software has a specific function which ensures your time is protected if there is a loss of the Internet connection. It is very difficult to explain the logic behind the clock. However, we can assure you that you are getting all of your time. Do not steadily watch the clock, but rather use it as a general guide. Long pauses between questions will result in the biggest time jump as the computers verify that you are still testing and did not loose the Internet connection.

UFM STUDY INFORMATION

This handout is intended to provide a few sample questions to help prepare for UFM tests. This includes 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 UFM4 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.

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**

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 no added pressure on the suction side of pump. 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 at churn) + (70 psi city) = 190 psi which would require a minimum 200 psi rated pipe.

QUESTION 6: FIRE PUMPS AND PRESSURES

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? The pump has a churn pressure of 120%.

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 + added pressure the pump provides. However, if a pump is rated at ## psi at a flow of #### gpm, then that same pump will produce a higher pressure at churn, or no flow. Churn is the condition when the pump is running, but no water is flowing. As such, the pump places a higher pressure on the pipe system.

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 (no city pressure) 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 on the suction side of the pump. 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 6b: Based on the answer from question 6a 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).

QUESTION 7: 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 what is the minimum size supply pipe needed to supply the system? 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.

QUESTION 8: FRICTION LOSS
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.

QUESTION 9: FRICTION LOSS
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

OTHER TYPICAL TYPE OF QUESTIONS ON BOTH UFM2 AND UFM4

1. Hydrants are required by NFPA 24 to be set on flat stones or concrete slabs and have small stones (or equivalent) placed around the base.
    - True
    - False

2. A device designed for the purpose of reducing, regulating, controlling, or restricting water pressure, is defines as:
    - Pumper outlet
    - Fire pump
    - Pressure Regulating Device
    - Gate valve

3. A test of a piping system using high velocity flows to remove debris from the piping system prior to it being placed in service, is defined as:
    - Hydrostatic test
    - Flushing test
    - Flow test
    - Pressure test

4. Indicating valves shall not close in less than ___ seconds when operated at maximum possible speed from the fully open position:
    - 3
    - 5
    - 7
    - 10

5. Each Fire Department Connection to a sprinkler system shall be designated by a sign indicating the service for which the connection is intended.
    - True
    - False

6. Unless approved by the AHJ, fire hydrants shall be located at least ___ feet from a building protected by the hydrant.
    - 20
    - 40
    - 60
    - 150

7. Establish how much leakage you are allowed when performing a hydrostatic test on a 200 foot section of 14 inch underground pipe:

    The question regarding leakage in a pipe is addressed by Table 10.10.2.2.6 of the 2010 edition. You do not need to use the equations. The values you need are in the table. You use the table to identify the amount of leakage for each 100 foot

section of pipe in gallons per hour. As indicated in the Table heading it is based on the testing allowance of gph or gallons per hour for each 100 feet of pipe. Thus, if you have a 200 foot section of 14-inch pipe you get a leakage of 0.134 gallons for each 100 feet. Thus, 0.134 x 2 (for 200 feet) = 0.268 gallons per hour.

Keep in mind that a hydrostatic test is required to be performed over two (2) hours. The answer so far is only for one hour. Thus for a two hour test you would take 0.268 x 2 = 0.536 gallon. If the question asked how much leakage per hour, than you would not need to double the answer of 0.268.

8. Establish how much leakage you are allowed when performing a hydrostatic test on a 350 foot section of 10 inch underground pipe:

   The question regarding leakage in a pipe is addressed by Table 10.10.2.2.6 of the 2010 edition. You do not need to use the equations. The values you need are in the table. You use the table to identify the amount of leakage for each 100 foot section of pipe in gallons per hour. As indicated in the Table heading it is based on the testing allowance of gph or gallons per hour for each 100 feet of pipe. Thus, if you have a 350 foot section of 10-inch pipe you get a leakage of 0.096 gallons for each 100 feet. Thus, 0.096 x 3.5 (for 350 feet) = 0.336 gallons per hour.

   Keep in mind that a hydrostatic test is required to be performed over two (2) hours. The answer so far is only for one hour. Thus for a two hour test you would take 0.336 x 2 = 0.672 gallon. If the question asked how much leakage per hour, than you would not need to double the answer of 0.336.

9. You have an underground fire main that is running on the uphill side of a retaining wall. If the frost line for the area is 5 feet, how far would the pipe need to be located horizontally from the retaining wall?

   The code requires that the pipe be buried at least one foot below the frost line to protect from freezing. Having cold air along the side of the retaining wall is just like having cold air above the ground. Thus, the pipe would need to be located at least as far from the retaining wall as it would be buried. So 5’ (frost line) + 1’ (below frost line) = 6’ minimum distance from wall.

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