TEL. : (514) 337-2600
FAX : (514) 337-2610

CIVELEC CONSULTANTS INC.
3900 COTE VERTU SUITE 200
ST-LAURENT (QUÉBEC) H4R 1V4

March 24, 2023

Planning, Real Estate and Economic Development Department - West Branch
City of Ottawa
110 Laurier Avenue West Ottawa, ON
julie.candow@ottawa.ca

Attention: Julie Candow, P.Eng, Project Manager

Subject: 22081-Rosefellow Kanata – Required Fire Flow Proposal – R.2
O/Ref.: 2301-01A

Julie,

To determine the water demand for fire protection based on the Fire Underwriters Survey, a document has been prepared by the Opta Information Intelligence Corp (formerly Insurance Advisory Organization). Part 2 of the document, contains a guide ("Guide for Determination of Required Fire Flows for Public Fire Protection in Canada), from here on referred to as the "Guide".

The subsection entitled "Risk Quantification with Required Fire Flows" states the following:

"*The Guide to calculate required fire flows is made available to municipal officials, consulting engineers and other interested stakeholders as an aid in estimating water supply requirements for public fire protection. This document is a guide and requires specialized knowledge and experience in public fire protection engineering for its effective application*."

The guide provides the following formula for estimating the fire flow required for a given area:

$RFF=220\ CA^{0.5}$

where RFF = Required Fire Flow
C = coefficient related to the type of construction
A is the total floor area of the building in m²

This formula only takes into consideration the building construction and the building area. The use of this formula provides a reasonable estimation for a building that does not have an adequate sprinkler system or that has a control mode density-area sprinkler system. The firefighting is based on a fire involving a majority of the building and the main objective is to limit the fire from spreading to other buildings and if possible extinguish the fire.

The modern-day sprinkler systems are designed to limit the fire to a relatively small area (by using Quick response sprinklers) and some are actually designed to extinguish the fire by using "Early Suppression Fast Response" sprinkler technology, as is the case in our situation. Since the proposed sprinkler design is based on the specific combustible loading of the building's occupancy content, the actual storage configuration, the actual height of the building and the clearances of the sprinklers with respect to the combustibles, it would be almost impossible to create a simple equation to estimate the fire flow that could be applied to all buildings of the same size given that most important criteria in determining the required water supplies in sprinklered buildings is based on commodity classifications for situations involving warehouses. As a number of sprinkler systems for speculative buildings are not designed for the actual combustible contents nor do they necessarily use ESFR sprinkler technology, the Guide uses a very conservative credit for sprinklered buildings.

The following examples will demonstrate the typical exceptions where the Guide would provide unreasonable flows (at times under-estimated and at times over-estimated) and where fire protection knowledge is required to determine the reasonable fire flows.

Example 1

We have a 1000 m^2 building of non-combustible construction. The building is used for storage of Class 1B flammable liquids in relieving-type metal drums 25 ft high on racks. The building is fully sprinklered. There is no required exposure protection.

In this example, the estimated fire flow would be:

220 x 0.8 x 10000.5 = 5,565 L/min

If we increase the flow by 25% for rapid burning fire, we get 6,957 L/min.

Assuming that we have a fully supervised sprinkler system, we can reduce the flow up to 50% yielding thus a RFF of 3,478 L/min or 920 usgpm.

The sprinkler system design for such an occupancy would require a density of 0.60 gpm/sq ft over an area of 3000 sq ft (flow of 1,800 gpm) plus in-rack sprinklers flowing 18 sprinklers at 30 gpm (flow of 540 gpm) and 500 gpm for hose streams yielding a total demand flow of 2840 usgpm or 10,750 L/min.

As we can see in this example, the real fire flow required to control the fire is approximately 3 times the flow calculated as per the Guide.

Example 2

We have a 150,000 m^2 building of non-combustible construction. The building is used for storage of car parts. The building is fully sprinklered. There is no required exposure protection.
In this case the required flow is:

220 x 0.8 x 150,0000.5 = 68,164 L/min

We did not increase the flow for medium hazard.

Assuming that we have a fully supervised sprinkler system, we can reduce the flow up to 50% and we obtain 34,082 L/min or 9,005 usgpm.

Giving a 50% credit for sprinklers is not reasonable. The sprinkler system is typically designed to control the fire within an area of 140 m^2. If the fire is not extinguished or controlled within the sprinkler design area, the fire will probably spread to the entire building and the credit for 50% would not work as the fire would behave as if the sprinkler system would not be present.

To protect this warehouse, there is almost no municipal water system that can provide these flows based on the Guide's estimation equation. These large warehouses are installed in industrial parks and the typical fire flows required to extinguish the fire are in the range of 5,000 L/min to 12,000 L/min (1320 gpm – 3170 gpm).

In this case, the calculations based on the guide require over 4 times more the water flow that is actually required to extinguish the fire.

These examples show why the experience in fire protection engineering is required to correctly determine the actual fire flows required to extinguish a fire.

Other Methods

Other than the FUS, several other organizations have developed simplified methods to determine the required water flow for fire protection purposes. The results vary over 150% depending on the organization.

NRC has developed a method that is based largely on building volume. The method determines the total water required for firefighting and then determines the required flow rate according to the water supply value obtained. It also limits the flow rate to a maximum of 9,000 L/min (2,378 gpm). For sprinklered buildings, the NRC method defers to NFPA 13 as the appropriate design standard for the water demand based on the sprinkler flow plus the hose stream demand. This method was included in the annex of the Ontario Building Code 2006 version.

Another method used to calculate water supplies can be found in NFPA 1142 which also uses building volume as its premise but utilizes a different formula. As was the case for the NRC method, the NFPA 1142 method first determines the total water required for firefighting and then derives the required flow rate. It limits the maximum flow rate to 3,900 L/min (1,030 gpm). When applying this method to fully sprinklered buildings with no exposure hazard, the water demand is the same as the water demand required for the sprinkler flow plus the hose stream flow as per the requirements of NFPA 13.

From these examples, we can see that the use of any of these methods without a detailed fire protection engineering analysis, can provide inconsistent results that can lead to inadequate water supplies or over exaggerated water supplies.

By code, large buildings require mandatory sprinkler protection. Consequently, when using the aforementioned methods, the volume of water calculations are replaced by the water supplies derived from the actual sprinkler flow rate (determined from NFPA 13 or other acceptable source), the number of hose streams expected to be used by the fire department, and the expected duration of the fire.

Flow Analysis

There are two reference standards (NFPA and FM) in the fire protection industry when it comes to sprinkler system design. NFPA 13 is the universal standard adopted in the United States and across Canada. The other is FM Global which has its own research centre and test labs. Both of these standards align when it comes to the specific sprinkler design criteria for the subject building. Both organizations also agree that a sprinkler design based on ESFR sprinklers, reduces the amount of water required for hose streams from 500 gpm (for conventional sprinklers) to 250 gpm and reduces the fire duration requirement from 120 minutes (for conventional sprinklers) to 60 minutes. This is due to the fact the ESFR sprinklers are designed to suppress the fire rather than simply "control" the fire.

The FUS method has a slightly different approach from the two methods discussed above. Unlike the NRC method or the NFPA 1142 method, the FUS first determines the flow rate (based on the building area and other site specific features) and then calculates the total volume of water required based on the derived flow rate and the projected fire duration. Furthermore, it does not differentiate between sprinkler flow and hose stream flow. Sprinkler flow is not dependent on building size but rather on the building's occupancy. It is calculated on a finite number of sprinklers operating regardless of the building size. As the FUS does not take into consideration the actual sprinkler flow but instead reduces the calculated flow by a "one size fits all" percentage, the calculated results in the FUS usually leads to flows that are unrealistic for large buildings and inadequate for small buildings.

Based on the FUS, the total required fire flow calculations for the subject building yielded a flow rate of 10,000 L/min (2,642 gpm) (see calculations attached with this report).

The NFPA 13 based design criteria for the subject building are summarized as follows:

Actual sprinkler flow rate using ESFR sprinklers = 5610 L/min (1482 gpm)
Hose stream allowance required when using ESFR sprinklers = 946 L/min (250 gpm)
Fire Duration when using ESFR sprinklers = 60 min

Because standard spray sprinkler systems require a hose stream allowance of 1892 L/min (500 gpm) for storage occupancies, there is a possibility that the fire department may draw 1892 L/min (500 gpm) instead of the 946 L/min (250 gpm) (required for ESFR sprinklers) during firefighting operations. We have therefore increased the hose stream demand by 250 gpm as part of our proposed analysis.

As per our analysis, the actual required water flow rate would be 7500 L/min (1982 us gpm).

To represent the required flow for adequate water supplies, the FUS calculated flow of 14,000 L/min (3698 gpm) was reduced to 1100 L/min (2906 gpm). This is represented in the FUS form under STEP I by providing a supplementary line whereby an additional reduction of 25% was applied due to the use of ESFR sprinklers in the building.

This 25% reduction still provides water supplies that are approximately 1000 gpm larger than the sprinkler flow and hoses (500 gpm).

As per the information available the city can supply over 11,000 L/min.

If you require any additional information, please do not hesitate to contact us.

Sincerely Yours,

Civelec Consultants Inc.

Paul Lhotsky, PhD, P. Eng., P. E.

LICENSED PROFESSIONAL ENGINEER
P. LHOTSKY
PROVINCE OF ONTARIO