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TechNotes

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The following issue of TechNotes has been written by Roland Asp, C.E.T., Manager of Installation Standards for the NFSA. Roland serves on the Technical Committee on Water Tanks which is responsible for NFPA 22 - Standard for Water Tanks for Private Fire Protection.

Water Tanks for Private Fire Protection: Capacity Requirements

NFPA 13, the Standard for the Installation of Sprinkler Systems and the other water based fire protection standards require at least one automatic water supply. The use of a water storage tank installed in accordance with NFPA 22, the Standard for Water Tanks for Private Fire Protection can be used to fulfill this requirement. In fact, NFPA 13-2016 section 24.2.1 requires the water supply to be one of the seven types identified. Of these seven acceptable types of water supplies, three of them fall under the scope of NFPA 22:

- A water storage tank at grade or below grade installed in accordance with NFPA 22 and filled from an approved source.
- A pressure tank in accordance with 24.2.4 and filled from an approved source gravity tank in accordance with 24.2.5 and filled from an approved source.
- A gravity tank in accordance with 24.2.5 and filled from an approved source.

Water tanks are commonly used to feed water-based fire protection systems in rural areas where public water supplies are not available, in areas where the public water supply provides insufficient flow, as an intermediate supply in vertically zoned buildings, and as a secondary supply in seismic zones or where the added reliability of a secondary supply is specified.

Most of the fire protection installation standards (NFPA 13D being the notable exception) reference NFPA 22 which

includes the minimum requirements for the design, construction, installation and maintenance of water tanks used as a water supply. NFPA 22-2013 is the current edition, although this standard is currently in the 2nd draft stage which will result in the 2018 edition of this standard. NFPA 22 recognizes the following types of tanks:

1. 1. Gravity Tanks (elevated tanks on towers or building structures)
2. 2. Suction Tanks (tanks on ground level or below that provides water to a fire pump)
3. 3. Pressure Tanks
4. 4. Embankment-Supported Coated Fabric Suction Tanks

Additionally, NFPA 22 covers the requirements for break tanks which is defined as "A tank providing suction to a fire pump whose capacity is less than the fire protection demand (flow rate times flow duration).

Acceptable tank materials are wood, steel (both bolted and welded), concrete, coated fabrics (Embankment-Supported Coated Fabric Suction Tanks) and fiberglass-reinforced plastic tanks. The requirements for each of these materials are found in a specific chapter of NFPA 22.

This TechNotes is concentrated on the required capacity of storage tanks serving fire protection system such as sprinkler systems. It will not discuss tanks that are required to meet fire flow capacity requirements for fire department use.

Required Capacity:
The basic requirement for calculating the minimum capacity of a storage tank for a fire protection system is simply determined by multiplying the flow demand of the fire protection system (from hydraulic calculations or pipe schedule) by the required duration which is found in the applicable installation standard. For example: Consider a hydraulically calculated light hazard sprinkler system with a flow demand of 190 gpm. NFPA 13 indicates that the minimum water supply duration for this light hazard sprinkler system is 30 minutes. With this information, the minimum usable water capacity of the tank would need to be: 190 gpm x 30 minutes = 5,700-gallons.

If this tank is an elevated tank, the minimum elevation height needed to provide the pressure would also need to be calculated. If the above referenced light hazard sprinkler system required a pressure of 52 psi at the base of the elevated tank, the minimum required tank elevation would be calculated simply by dividing the required pressure by

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0.433 psi/ft (52 psi/ (0.433 psi/ft) = 120 ft) or by multiplying the pressure by 2.31 ft/psi (52 psi x 2.31 ft/psi = 120 ft). Therefore, this elevated tank needs to be at least 120 ft high. Note that this elevation needs to be maintained for the lowest usable water level of the tank to ensure that this minimum required pressure is available even when the tank is near empty.

The water capacity for a pressure tank follows the same procedure however the tank size must be increased to allow room for the air that, when pressurized will push the water out of the tank to the fire protection system. The annex of NFPA 22 (2013) in A.7.1.4.2 provides guidance for properly sizing pressure tanks. It needs to be noted that NFPA 13 includes additional capacity requirements when the pressure tanks are serving a dry pipe or preaction systems. For dry and preaction systems NFPA 13 requires that the water capacity of the pressure tank also includes the extra capacity to fill the dry system or preaction system piping (NFPA 13 (2016) section 24.2.4.2.1). It should also be noted that NFPA 22 requires that the capacity of a pressure tank be approved by the AHJ.

The water tank capacity that we are concerned with is not the actual volume of the tank but rather its usable volume or net capacity. The actual capacity will always be larger than the net capacity, which is the number of gallons available to the fire protection system that it serves. For suction tanks this means the net capacity is the number of gallons between the elevations of the vortex plate and the inlet of the overflow pipe. For elevated tanks the net capacity is the number of gallons between the elevations of the discharge pipe and the inlet of the overflow pipe.

Counting on automatic refill when sizing a tank:
NFPA 22 allows an automatic refill rate to be considered when sizing a tank. This allowance is also implied in the other installation standards such as NFPA 13. This allowance is found in NFPA 22-2013 section 4.1.4 and reads as follows:

4.1.4 A tank shall be sized so that the stored supply plus reliable
automatic refill shall be sufficient to meet the demand placed upon it for the design duration.

This allowance applies to all tanks. When a fire pump is used with this tank, the tank is called a "break tank," which is defined as "a tank providing suction to a fire pump whose capacity is less than the fire protection demand." NFPA 22 provides specific requirements regarding the refill mechanisms for break tanks which will be discussed later in this article.

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Other types of tanks without a fire pump would not technically be considered break tanks but the reliability and arrangement of the refill mechanisms must be evaluated to ensure that the capacity is adequate to meet the required duration of the fire protection system.

Another related question commonly asked is: "Are storage tanks required to have an automatic refill? The answer is no, as long as the tank is sized so that the usable volume meets the required net capacity (duration x the demand) for the fire protection system. NFPA 22 is the standard that governs the design of the tank and its equipment and there is no requirement in this standard (or any other NFPA standard) to automatically fill any tank that already meets the required net capacity needs for all fire protection systems fed by the tank.

Break Tanks:
The guiding principle of break tanks is that the stored water supply and the automatic refill rate must meet the system demand for the required duration.
Break tanks are used as: a backflow prevention device, to eliminate pressure fluctuations in the public water supply, and to augment the city water supply when the available volume from the city in inadequate.

NFPA 22-2013 section 4.1.5 states the minimum capacity of a break tank is one sized for a minimum duration of 15 minutes with the fire pump operating at 150 percent of the rated capacity. This section reads follows:

4.1.5 A break tank shall be sized for a minimum duration of 15 minutes with the fire pump operating at 150 percent of rated capacity.

Specific rules applying to sizing and arrangement of refill mechanisms must be followed for break tanks. These rules are found in NFPA 22 section 14.5.3, which provides two sets of requirements. A set of requirements is provided for break tanks having a capacity equal to the maximum system demand for a duration of 30 minutes or more and another set of requirements for tanks with smaller capacities.

In both cases, the refill mechanism must be listed and arranged for automatic operation.
An overview of the refill mechanism requirements for these tanks is as follows:

Break Tanks: Less than 30-Minute Capacity:

- Dual automatic refill lines each capable of filling the tank at 150% of pump capacity.
- Manual tank fill bypass capable of filling the tank at

150% of pump capacity.
- If the water supply is not capable of filling tank at 150% of rated pump capacity, the automatic and manual refills must be capable of refilling the tank at a rate that meets or exceeds 110 percent of the maximum fire protection system design flow.

Break Tanks: 30-Minute Capacity or more:

- One automatic refill line capable of providing 110% of the rate required to provide the total fire protection system demand
- Manual tank fill bypass capable of providing 110% of the rate required to provide the total fire protection system demand

These rules for break tanks were added to NFPA 22 in the 2013 edition. Prior to this edition, these rules were found in NFPA 20 - Standard for the Installation for Fire Protection.

Although not directly related to the required capacity of water tanks, I would like to note that that NFPA 22 does state that when a tank does not have sufficient capacity to meet the demand of the fire protection system that it serves, the impairment procedures of NFPA 25 must be followed. Additionally, the means to fill the tank must be sized to fill the tank in a maximum time of 8 hours.

Hose stream allowance:
Another common question is: Do tanks need to be sized to include a hose stream allowance? The answer to this question is "it depends".

Tanks are only required to have sufficient water for the equipment that they serve. This requirement is found in NFPA 13-2016 section 11.1.5.2. As stated in the annex to this section: If the tank only serves a sprinkler system and does not serve any fire hydrants or hose connections, then the tank needs only to be sized to handle the sprinkler demand. No inside or outside hose stream allowance is required to be accounted for.

If, however, the tank does serve hydrants or hose connections in addition to the sprinkler system then the hose stream allowance would need to be included with the tank sizing.

For further information regarding hose stream demands and sizing of water tanks, see TechNotes Issue #275 dated September 3, 2013. This TechNotes which is available to members is available on the NFSA website.

Conclusion:

NFPA 22, the Standard for Water Tanks for Private Fire Protection includes the minimum requirements for the design, construction, installation and maintenance of tanks and accessory equipment that supply water for private fire protection. Many of these requirements will fall to the tank manufacturer and specifying engineer, however, the minimum required capacity of these tanks is the responsibility for the layout technician and would be based on the type of fire protection system being supplied. The overriding principle that must be observed is that the water supply, in this case, the water tank must be sized to provide the minimum required net capacity (duration x the demand) for the fire protection systems it serves.