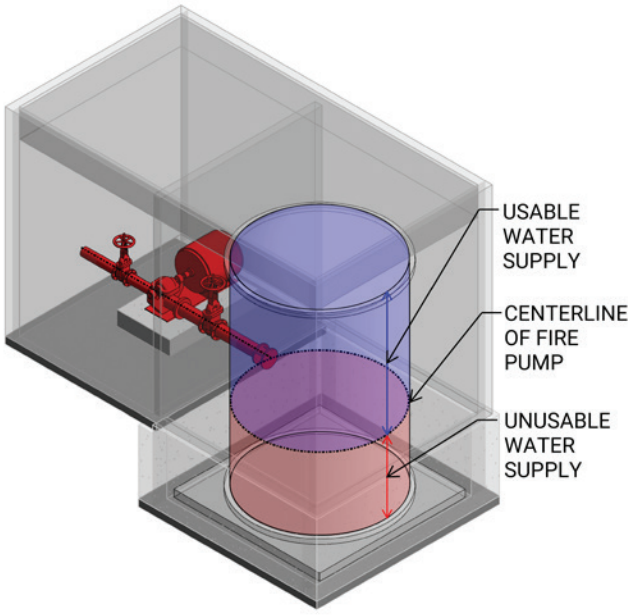
Best of EOD: Fire Pumps and NFPA 20

by Jeff Dunkel, P.E.

The NFSA responds to EOD questions daily on wide variety of codes and standards, the vast majority of which are NFPA 13 questions. However, questions about NFPA 20 are common, and for good reason, it can be complicated. In this edition of NFSM, I have chosen a few questions that are both common and applicable to most fire pump designs. These examples are what I will call the "Best of EOD" regarding NFPA 20. This article will provide both the question that was submitted along with the answer provided. Also included is the background for these requirements and illustrations to provide further clarity.

Question 1: Suction Tank Elevation in Relation to Vertical Turbine Fire Pump

The proposed pump/tank arrangement as shown in the sketch seems to be poor for any type of pump. A centrifugal pump cannot rely on a lift per NFPA 20, 2019 edition, Section 6.1.2, so any water below the intake could not be considered usable for the secondary onsite required water supply for a high rise. A vertical turbine pump would not work as the water pressure from the above grade portion of the tank would cause it to come out of a vertical turbine pump well. Are there any other solutions besides lowering the tank below grade for a vertical turbine pump or raising it level with the intake of a centrifugal pump?



Answer 1:

No, based on the information provided, there are no other solutions when using a horizontal split case or vertical in line pump at the elevation of the pump room floor. The useable water would only be that above the centerline of the pump. To use a vertical turbine pump, the pump would have to be located above the tank and the water level in the tank would have to be located below that of the fire pump room floor.

Given the diagram provided for the tank, the following options could be considered:

1. Provide a horizontal spilt case or vertical inline pump at the fire pump room floor elevation and ensure the volume of the tank above the centerline of the pump can meet the system demand.
2. Lower the floor of the pump room to the water tank pit elevation and use a horizontal spilt case or vertical inline pump and the entire volume of the tank.
3. Lower the top of the tank to an elevation below the floor elevation of the pump room and provide a vertical turbine pump directly on top of the tank or on top of an associated pump vault or well below the fire pump room.
4. Provide a vertical turbine pump in a fire pump room located directly above the tank.

Centrifugal pumps must be continuously primed to work properly, if these pumps loose prime, they will become air bound. When air is introduced into the pump the impeller is incapable of forcing the air out to bring more water in. In order to ensure there is a consistent supply of water, the minimum level of the water supply must be above the centerline of the fire pump. In addition to a minimum water level the pressure at the suction flange must be above 0 psi when supplied by an underground water main, and minimum of -3 psi when supplied by a suction tank.

While the pressure on the suction line is permitted to be negative

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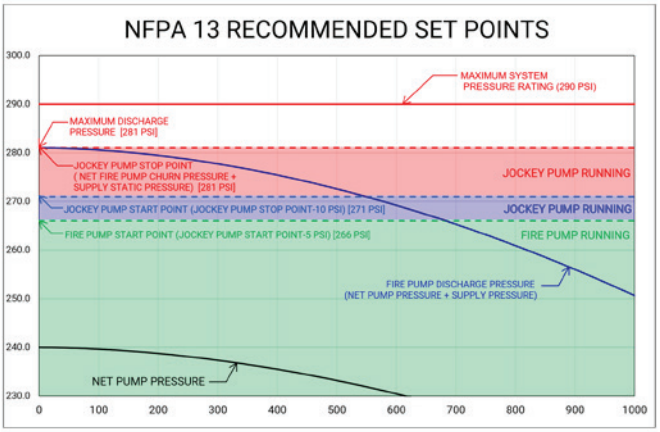
for suction tanks, this is not an allowance for drafting. The -3 psi allowance is intended to accommodate the pressure loss due to friction from the pipe between the tank and the pump. Without this allowance all tanks serving fire pumps would either need to be gravity tanks or a portion of the supply in the tank would be unusable.

Question 2: Fire Pump/Jockey Pump Set Points

Fire pump churn is 240 psi and city static at suction is 41 psi. The maximum working pressure of jockey pump with city pressure is 273 psi so it can't meet the 281 psi suggest cut out point. How low of a cut out point for the jockey pump would be acceptable? Would it have implications with the fire pump if the setting are too low?



Answer 2:

NFPA 20, 2016 edition, Section 4.26.4 requires the pressure maintenance pump have discharge pressure sufficient to maintain the desired fire protection system pressure.

It should be noted that Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

NFPA 20, 2016 edition, Section A.14.2.6(4) suggests that the jockey pump stop point should equal the pump churn pressure plus the minimum static supply pressure. In your case this would be the 281 psi. The jockey pump start point should be at least 10 psi (0.68 bar) less than the jockey pump stop point. In your case this would be 271 psi. The fire pump start point should be 5 psi (0.34 bar) less than the jockey pump start point. In your case this would be 266 psi.

The handbook commentary on this section indicates because the main fire pump start point is lower than the pressure maintenance pump start point, care should be taken to ensure that the settings given in Section A.14.2.6.(4) (b) are not so low that a pressure shock is created when the main fire pump finally does come on.

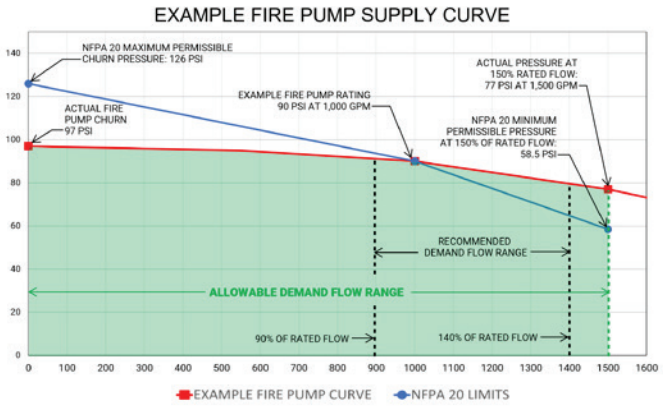
With the annex recommended start pressures, the fire pump would start at 266 psi and raise the system pressure to 281 psi for a 15 psi increase in pressure.

With the jockey pump you currently have, the jockey pump start pressure would be 263 psi and the jockey pump stop pressure would be 273 psi. This would make the fire pump start pressure 258 psi and raise in the system pressure to 281 psi for a 23 psi increase in pressure. This is an additional 8 psi increase in system pressure when compared to the recommended pressures provided by the annex.

The standard does not provide a prescriptive requirement for pressure maintenance and fire pump start pressures. The intent is to ensure the settings are not so low that a pressure shock is created when the main fire pump starts. The design professional, AHJ, and fire pump manufacturer's representative should be consulted and agree on the settings, however it seems reasonable to start the fire pump at 258 psi in your example and increase the pressure to 281 psi.

Question 3: Fire Pump Capacity

With fire pumps "rated" out to 150% of their designed flow, is there anything in the NFPA standards stipulating or recommending how far out on the pump curve a calculation demand can go? In other words, can you calculate a system demand and utilize up the 150% of the pumps rated capacity? Does FM Global have their own criteria?



Answer 3:

NFPA 20, 2019 edition, section 4.10.1 indicates a centrifugal fire pump for fire protection shall be selected so that the greatest single demand for any fire protection system connected to the pump is less than or equal to 150 percent of the rated capacity (flow) of the pump.

Annex Section A.4.10 indicates: "The performance of the pump when applied at capacities over 140 percent of rated capacity can be adversely affected by the suction conditions. Application of the pump at capacities less than 90 percent of the rated capacity is not recommended."

Factory Mutual FM Data Sheet 3-7 section 2.5.1 dictates pumps shall be sized to meet the maximum required flow and pressure demand for the system. Section 2.5.2 states that for centrifugal pumps, a maximum of 140% of the pump rated flow capacity shall be used to meet the combined system demand and hose streams (if also supplied by the fire pump).

Fire pumps can be sized by NFPA 20 with a fire protection system demand (including hose stream if applicable) up to 150% of the

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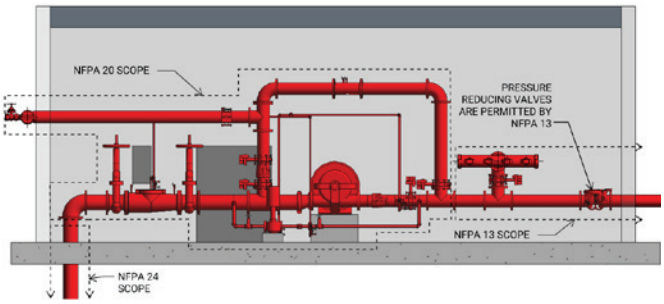
pump's rated capacity, but the annex recommends not to exceed 140% of the pump's rated capacity. Factory Mutual requires fire pumps to be sized with a total system demand (including hose stream if applicable) up to 140% of the pump's rated capacity. For example, a 1,000 gpm rated fire pump can be used to supply fire protection system demands up to 1,500 gpm by NFPA 20 (maximum 1,400 gpm recommended) and up to 1,400 gpm by Factory Mutual

Question 4: Pressure Reducing Valve Location

We have an ESFR warehouse with fire pump. During churn condition, the pressure exceeds 175 psi. Can a pressure reducing valve be installed after the pump discharge isolation valve?



Answer 4

Yes, the NFPA 20, 2016 edition, requirements for pressure reducing valves only applies to the fire pump discharge piping which is up to and including the fire pump discharge control valve. After the fire pump discharge control valve, the specific system standards are applicable such as NFPA 13 and/or NFPA 14 which do allow pressure regulating devices with some restrictions. The maximum pressure from the fire pump discharge would need to be satisfied up to and including the pressure reducing valve.

Section 4.16.11 for pressure regulating devices indicates no pressure regulating devices shall be installed in the discharge pipe except as permitted in this standard. Section 4.16.1 indicates the discharge components shall consist of pipe, valves, and fittings extending from the pump discharge flange to the system side of the discharge valve.

Section 4.7.7.2 indicates pressure relief valves and pressure regulating devices in the fire pump installation shall not be used as a means to meet the requirements of 4.7.7.1 for maximum system pressure. Section A.4.7.7.2 indicates it is not the intent of this subsection to restrict the use of pressure reducing valves downstream of the discharge isolation valve for the purpose of meeting the requirements of 4.7.7.

I suggest locating the pressure regulating valve as far away from the jockey pump controller sensing line as possible to increase the volume of water in the pipe and help dampen the change in pressure when the pressure regulating valve opens or closes to control discharge pressure.

Why does it matter if the pressure reducing valve is down stream of the discharge control valve? NFPA 20 prohibits the use of pressure reducing valves primarily to ensure the selected fire pump is not capable of exceeding the system pressure rating without the use of a regulating device that can fail. Using a pump that does not exceed the system pressure rating is best practice, however not always achievable. High pressure demands or systems at high elevations relative to the water supply could create a situation where the demand cannot be met without a pump churn exceeding the system rating, which is why pressure regulating devices are still permitted by NFPA 13 and NFPA 14.

There are two situations where NFPA 20 specifically permits the installation of pressure reducing valves. The first is for systems supplied by a variable speed drive where the churn pressure could exceed the system rating if the variable frequency drive were to fail. The second is for diesel driven pumps where 121 percent of the maximum discharge pressure (churn plus static pressure) exceeds the system pressure rating. •