MEASURE 3.3.1.2 Install gravity tanks or pressurized storage tanks.

RATINGS

New Facilities	Retrofit	O&M
C	C	

This subsidiary Measure recommends another way to minimize the energy needed to pressurize the service water system. This approach relies on one or more tanks to maintain pressure on the system. The system's pumps are used only to refill the tanks, so they operate only intermittently.

This is usually the most efficient method. The average rate of water usage in most facilities is much less than the peak consumption, so the pumps are stopped most of the time. The pumps can be optimized for the single pressure and flow rate needed to refill the tank. By the same token, the capacity of the pumps does not affect efficiency, unlike systems where the pumps provide system pressure directly.

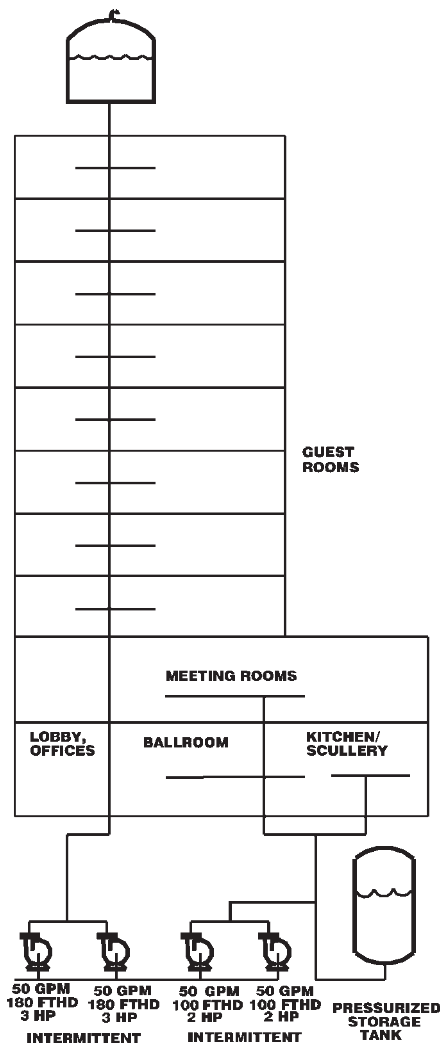

Fig. 1 Gravity tank and pressurized tank Using storage tanks eliminates excess pump operation. In addition, splitting the building into pressure zones improves pumping efficiency.

SUMMARY

Allows the pumps to operate at their maximum efficiency. Provides stable water pressure. Requires a separate water heater and recirculation system for each pressure zone. In retrofit, structural support for the tank(s) may be a problem, but clever design can minimize tank size.

SELECTION SCORECARD

Savings Potential .... $ $

Rate of Return, New Facilities % % %

Rate of Return, Retrofit .... % %

Reliability .... ✓ ✓ ✓ ✓

Ease of Retrofit...................... ☺ ☺

You have a choice of two types of tanks. You can install a simple gravity tank, which must be located above the highest water user in the system. Or, you can install a closed, pressurized tank at any elevation.

Figure 1 illustrates both types installed in the hotel that we have been using as an example in the previous Measures. The tall portion of the building is served by a standpipe located above the roof. The lower portions of the building are served by a closed pressurization tank located in the equipment room.

From the standpoint of energy efficiency, gravity tanks and pressurized storage tanks are essentially equal. The choice between the two usually does not affect the other components of the water system. The choice is guided mainly by relative cost and by the structural limitations of the building. Each tank requires only one pump, with perhaps a second reserve pump.

This method is likely to be more expensive than the methods of Measure 3.3.1.1, but this is not always true. This method adds cost for the tank(s) and supporting structure, but it may add relatively little piping cost. In new construction, the additional structural cost may be minor. However, structural support may be a large cost in retrofit, especially for standpipes on top of the building. In new construction, this method allows the pumps to be much smaller.

As in Measure 3.3.1.1, a separate hot water heater and recirculation system is needed for each pressure zone, i.e., for each pressurization tank.

Standpipes

A "standpipe," or gravity tank, is an elevated tank that is intended to store water and to maintain a steady water pressure. In a standpipe system, water pressure is provided entirely by gravity and it is determined by the height of the tank above the user. The tank is vented and requires no accessories, except for a level switch to control the operation of the pump that fills it. Figure 2 shows a number of gravity tank installations.

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Fig. 2 Gravity tanks These buildings use gravity tanks for two purposes, pressurizing the domestic water system and providing a separate source of water for fire protection. In most of these buildings, separate tanks are used for the two purposes. The elevation of the tanks above the roofs provides adequate pressure for the upper floors.

Many buildings have gravity tanks for fire protection. The tank ensures both an adequate quantity of water and adequate pressure. A fire protection tank can also pressurize the service water system.

When considering a gravity tank, assess the ability of the building's structure to carry the localized weight of the tank and its contents. In new construction, this may be a minor matter. A filled service water pressurization tank may weigh less than a boiler or a chiller. You can minimize the size of the tank by selecting the pump capacities carefully, as explained below.

A gravity tank must be located well above the highest level of water usage in order to provide adequate pressure. For example, if you need to provide 15 PSI to the top floor of a building, the water level in a gravity tank must be 35 feet above the tallest fixture.

If only a small amount of water is needed at the highest level in the building, it is more practical to use a small booster pump with a separate riser that serves just the upper floors of the building, as shown in Figure 3. This makes structural support easier. It also reduces the problem of freeze protection, which is discussed below.

The cheapest way to refill the tank is through the service riser. However, this causes pressure fluctuations at the user equipment when the pump starts or stops. You can damp these fluctuations by using a surge

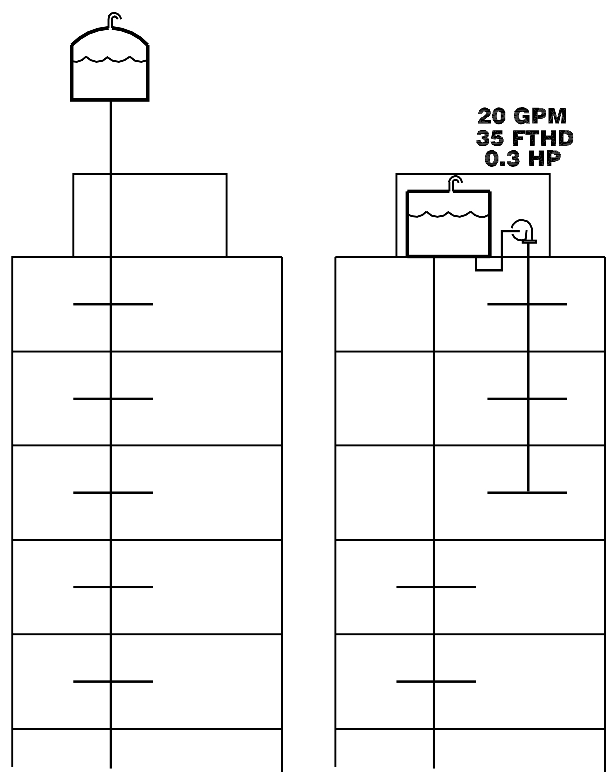

Fig. 3 How to provide pressure to the upper floors
As a third approach, you could add a small pressurization tank just to serve the upper floors.

absorber, described previously. You can eliminate the fluctuations completely by installing a separate pipe to refill the tank.

Closed Pressurization Tanks

You can also store system pressure with a closed pressurization tank. This is simply a tank that has an air space to provide pressurization. A small air compressor replenishes the air occasionally as it is absorbed slowly into the water. Figure 4 shows an example.

A pressurization tank has the advantage that it can be installed anywhere in the service water system, provided that the piping is of adequate size at that point.

The tank wall thickness is proportional to the diameter of the tank, so it is desirable to keep the tank as small as possible. You can minimize the tank capacity by selecting the pump capacities carefully, as explained below. In a tall building, you can reduce the tank's pressure rating by installing it high in the system.

A pressurization tank acts as a surge absorber. The tank is most effective in this role if it is located near the pump discharge.

How to Select Tank Capacity and Pump Size

In a standpipe system, the pump turns on and off continually. The starting current of a motor is several times the normal full-load current, so frequent starting causes the motor to run hotter than normal. Calculate the maximum cycling rate that you can expect. Then, select the motor accordingly. See Measure 10.1.1 for guidance in selecting motors.

The size of the tank is determined primarily by the need to limit pump motor cycling. Here is an example.

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Fig. 4 Service water pressurization equipment in the basement of a tall office building The closed tank on the right maintains constant water pressure. The three pumps on the left operate in sequence.

The peak flow rate is about 1,000 GPM, the pump has a capacity of 1,000 GPM, and the tank has a capacity of 2,000 gallons. The cycling behavior of the pump at different rates is:

Consumption Rate (GPM)	Pump ON Time (minutes)	Pump OFF Time (minutes)	Motor Starts per Hour
1,000	continuous	none	0
800	10	2.5	5
600	5	3.3	7
400	3.3	5	7
200	2.5	10	5
100	2.2	20	3

This example shows that the number of motor starts per hour remains fairly constant throughout a wide range of water demand rates. A large tank capacity is needed to extend the period of time that the pump remains off. The number of motor starts per hour is inversely proportional to the tank capacity.

Greater pump capacity shortens the time needed to refill the tank, somewhat increasing the number of motor starts per hour. The pump capacity should be able to satisfy the maximum continuous flow requirement, but there is no merit in adding additional pump capacity, except to add a spare pump.

This analysis suggests a way of reducing the tank capacity. Namely, divide the pump capacity among several smaller pumps. Use a series of tank level switches to operate individual pumps, so that the minimum number of pumps are operated to satisfy the current demand flow rate. This slows the rate of filling and matches pump output to the flow requirement, allowing tank capacity to be reduced without excessive pump cycling.

For example, if the maximum expected flow rate is 1,000 GPM, install three pumps, each of 350 GPM. Install four tank level switches, at 100%, 30%, 20%, and 10% of full capacity. One pump is started when the tank level falls to 30%, a second when the tank level falls to 20%, and the third when the tank level falls to 10%. All pumps are turned off when the tank is filled to 100%.

Extending this example, a fourth pump can be installed as a spare. It is controlled with a level switch located at, say, the 5% level. It starts automatically if any of the other pumps fails, or if the maximum flow rate is greater then estimated.

Using Existing Pumps

If you add a standpipe or pressurization tank to an existing facility, consider using one or more of the existing pumps for refilling the tank. You may be able to save even more energy by trimming the pumps to operate at the lowest practical pressure. See Measure 10.2.1 for details of pump impeller trimming.

Freeze Protection of Exterior Tanks

Exterior tanks have been used for years in many cities with colder climates, such as New York City. A tank located outside the building in a cold climate should be insulated. The large mass of water keeps the tank from freezing, as long as some flow through the tank occurs on a daily basis. However, heat loss from the tank increases the energy required for heating the water. Exposed connecting pipe is vulnerable to freezing. Preventing this requires heat tracing of the pipe, which uses energy.

You can avoid the freezing problem entirely by keeping the tank within a heated space, such as an equipment penthouse. If you do this, provide adequate pressure for the upper floors with a small booster pump, as suggested previously.

ECONOMICS

SAVINGS POTENTIAL: *40 to 80 percent of service water pumping energy.*

COST: *$10,000 and up.*

PAYBACK PERIOD: *Several years or longer. The payback period is best with large motors and easy piping.*

TRAPS & TRICKS

DESIGN: *The concepts are simple, but there is room to do a better job than is often found. You can substantially reduce the tank size and the corresponding structural support requirements by taking care in selecting pump capacities and designing pump controls.*

EXPLAIN IT: *Describe the system in the plant operating manual, including the pump operating sequence. Install a placard at the pump controls that states the sequence.*