Published on *MTAS* (https://www.mtas.tennessee.edu) February 22, 2020

Protecting Public Water Systems

Dear Reader:

The following document was created from the MTAS website (mtas.tennessee.edu). This website is maintained daily by MTAS staff and seeks to represent the most current information regarding issues relative to Tennessee municipal government.

We hope this information will be useful to you; reference to it will assist you with many of the questions that will arise in your tenure with municipal government. However, the *Tennessee Code Annotated* and other relevant laws or regulations should always be consulted before any action is taken based upon the contents of this document.

Please feel free to contact us if you have questions or comments regarding this information or any other MTAS website material.

Sincerely,

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Protecting Public Water Systems

Reference Number: MTAS-1893

The Fire Service’s Role in Protecting Public Water Systems

Clean, safe, drinking water is something we take for granted, and every fire department needs to follow industry standard best practices to protect the water system and be aware of practices that threaten our public drinking water. Ensuring our water is safe is everyone's responsibility, including the fire department.

The public water system that supplies our drinking water is the same system firefighters use to supply water for firefighting efforts. Fire departments routinely connect apparatus to fire hydrants and thereby use public drinking water for firefighting. Fire departments serving areas with a public water supply usually refill the water tank on the fire apparatus using a fire hydrant or an outlet at a fire station that is connected to the public water system.

Significant efforts by the Federal government, the Tennessee Department of Environment and Conservation (TDEC), and others have improved water quality in public water systems. Most of this work has been a result of federal and state laws that have been enacted insuring the public water is safe to drink. Congress passed the first legislation regulating drinking water at the national level in 1974. The Safe Drinking Water Act provided the basis for national requirements on water quality standards and water supply operation. Tennessee uses this model to set state regulations concerning public water systems. The two biggest areas of concern for protecting the water system are been cross connections and backpressure contamination.

Cross-Connections

Reference Number: MTAS-1894

A cross-connection is an actual or *potential* connection between a potable (safe to drink) water supply and a non-potable (unsafe to drink) source, where it is possible for a contaminant to enter the drinking water supply.

In the residential setting, a cross connection is a direct link between a household water line and a contaminated source such as a garden hose, toilet tank, laundry tub, swimming pool, lawn sprinkler system, etc. The most common contaminants, such as pesticides, sewage, and detergents, can enter the public drinking water system through cross connections in home water lines. Most household cross connections are created by hoses. Under certain conditions, the flow in household water lines can reverse and siphon contaminants into the water supply. For example, using a garden hose to spray pesticides is normally harmless, but if the city's water supply is interrupted during the spraying, the potential for contamination exists. If water main pressure is reduced due to a water main break or nearby firefighting operations, a back siphonage effect is created. This can draw pesticide from the sprayer through the garden hose into the household water lines and possibly the water main. The contamination may be localized (the home), or spread through the water mains to other areas.

The public water system can also be contaminated by an effect called backpressure. Backpressure results when the water supply is connected to a system under high pressure such as a hot water boiler for home heating or a portable pressure washer. Since the pressure in these devices is higher than the normal home water supply, water can sometimes be forced backwards. Contaminants in these systems, such as cleaners or soaps in a pressure washer, can enter and contaminate the public drinking water supply.

In the fire department setting, cross-connections occur when a garden hose or fire hose is submerged into the water tank when filling a fire truck, when pulling the residual pressure too low on a fire hydrant, and even when a fire engine is being filled directly from a fire hydrant. An on-board foam system, such as a CAFS system, can introduce firefighting chemicals into the water system. These are only a few examples, and many more exist. As in the residential setting, a fire department created cross-connection or backpressure problem can contaminate the public water system.

Regulations on Fire Hydrants

Reference Number: MTAS-1895

Tennessee Water Regulations

Tennessee Department of Environment and Conservation (TDEC) regulations affect the way any fire department uses fire hydrants connected to a public water system. The current TDEC regulations took effect on January 1, 2006 and follow the 1996 Amendments to the Safe Drinking Water Act. TDEC regulations emphasize the protection of the public water supply and the prevention of introducing pollutants and contaminants into water systems.

The original rules in Tennessee were adopted in June 1974, and have changed at least four times over the past 43 years. On October 29, 2005, TDEC adopted state water regulations requiring all communities having or installing water systems to protect the system against contamination and to identify fire hydrants connected to the system. These rules are from the Tennessee Department of Environment and Conservation, Bureau of Environment – Division of Water Supply. The Rules and Regulations are issued under the authority of Public Acts of 1983, Chapter 324 where the Division of Water Supply is responsible for the supervision of all public water systems.

The purpose of these Rules and Regulations is to provide guidelines for the interpretation of T.C.A. § 68-221-701 *et seq.* and to set out the procedures to be followed by the department in carrying out the State's primary enforcement responsibility under the Federal Safe Drinking Water Act.

The rules apply to all public water supply systems that provide water for human consumption through pipes or other constructed conveyances, if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year.

According to the revised rule Paragraph (18) of Rule 0400-45-1-.17 Operations and Maintenance is amended in its entirety and substituting the following so that as amended the paragraph shall read:

(18) All community water systems planning to or having installed hydrants must protect the system from contamination. All water mains designed for fire protection must be six inches or larger and be able to provide 500 gallons per minute with 20 pounds per square inch residual pressure. Fire Hydrants shall not be installed on water mains less than six inches in diameter or on water mains that cannot produce 500 gpm at 20-psi residual pressure unless the tops are painted red. Out of service hydrants shall have tops painted black or covered with a black shroud or tape.

Existing Class C hydrants (hydrants unable to deliver a flow of 500 gpm at a residual pressure of 20 psi) shall have their tops painted red by January 1, 2008.

The water system must provide notification by certified mail at least once every five years beginning January 1, 2008, to each fire department that has reason to utilize the hydrants, that hydrants with tops painted red (Class C Hydrants) cannot be connected directly to a pumper fire truck. Fire Departments may be allowed to fill booster tanks on any fire apparatus from an available hydrant by using the water system's available pressure only (fire pumps shall not be engaged during refill operations from a Class C hydrant).

The complete list of TDEC rules is available online at the Tennessee Secretary of State's website at https://publications.tnsosfiles.com/rules/0400/0400-45/0400-45.htm [1]

A Matter of Public Health

Reference Number: MTAS-1896

So what does the fire department do: let the house burn down, or risk contaminating the water system? Either way, it is a matter of public health.

These are very good questions and should be decided before responding to a house on fire. A coordinated effort between the fire department and water utility is essential in protecting public health in these situations. In many cases, this cooperation has not always existed between the two departments. Issues related to locating fire hydrants have caused problems in many communities for years. One problem is locating fire hydrants strategic to fire department operations. The fire department's view is typically not the same as the water utility's view, especially in allowing for water system flushing. Who has the authority for properly locating fire hydrants? Different jurisdictions have different interpretations of this question. The answer should be that the fire department and water utility work together on these issues.

As required by Rule 0400-45-1-.17(18), the water purveyor must, at least once every five years, notify by certified mail every fire department served by that water system that certain fire hydrants cannot be used for firefighting. Most fire chiefs would say that this is pretty strong language but in the event of an emergency, decisions to use or not to use fire hydrants must be made. Who will assume the liability at the time of a fire where a fire hydrant is available but the fire department is not allowed to use it? Who will assume the liability if the water system becomes contaminated? Water officials can be held personally liable for allowing the system to become contaminated. Many fire service leaders believe the restriction on using Class C fire hydrants is too unreasonable especially in the event of a possible rescue of a trapped victim.

Can people actually get sick from the fire department connecting to a Class C fire hydrant? Will this actually contaminate the water system? According to several recognized articles by the Federal Environmental Protection Agency, there have been documented cases where water contamination occurred due to something that a fire department did or did not do. This way of contamination is quite difficult to pinpoint although a backpressure situation can occur anytime fire apparatus is connected to almost any fire hydrant.

In most cases where waterborne disease outbreaks have occurred, they have resulted in nausea, diarrhea, and cramps, however it is possible in some cases to result in very serious illness and even death. Experts believe that most waterborne disease outbreaks are not recognized, so in truth, there may have been many times more than what is reported. According to the American Water Works Association (AWWA), “Cross-connection contamination can provide an opportunity for large amounts of biological material to enter the distribution system. These events generally result in noticeable change in water quality, including turbidity, increased content of solids, and undesirable tastes and odors.” However, in a report released by TDEC entitled “Tennessee Rural Water Needs Report” it states that only a very small percentage (less than 1%) of the domestic water used in a typical household is for drinking purposes. Therefore, if contamination does occur, there is a small chance that people will be adversely affected.

Fire officials have stated that fire departments seldom connect hard suction hose to fire hydrants, and therefore the possibility of causing a backpressure in a water system is minimal. Most fire departments use a soft vinyl hose to connect the pumper to the fire hydrant rather than the rigid hard rubber hose that was common many years ago. Unlike the hard suction hose, the vinyl hose will collapse as the residual pressure is dropped. Occasionally there could be a need for hard suction hose on a large fire but most fire departments do not carry hard suction hose any more. The exception to this is in rural areas where drafting from ponds or other surface sources is necessary or in tanker shuttle operations where a fire engine is used to draft from a dump tank. Regardless, using hard suction hose is a last resort operation for most fire departments.

The response to the observation that hard suction hose is seldom used is that it is still possible for the fire department, regardless of the type of suction hose used, to reduce the water pressure in the water mains to a point that results in back siphonage. The civil engineering definition of back siphonage is, “The flowing back of used, contaminated, or polluted water from a plumbing fixture or vessel into the pipe which feeds it; caused by reduced pressure in the pipe.” The possibility of back siphonage and potential contamination negates the argument that fire departments seldom use hard suction hose.

Deficient Fire Flows

Reference Number: MTAS-1897

Why Communities Have Deficient Fire Flows

A community that discovers it has areas with deficient fire flows may wonder how that happened, and wonder why the water system and fire hydrants were installed while being inadequate for the community's fire protection needs. The reasons are many, but the most common reason a community has deficient fire flows is poor planning.

Water mains of four inches in diameter are adequate for supplying water for domestic use, such as for drinking, cooking, bathing, etc. In many rural areas, four-inch mains were installed to allow for the development of homes. However, a four-inch water main is incapable of supplying enough water to fight a fire. In addition, TDEC regulations require water mains of six inches or larger for the installation of fire hydrants. It is possible that developers, planners, builders, and others who are not aware of the need for adequate fire flows did not consult with the local fire department during the planning and design phase of a project. This is a key reason why it is critical that the fire department be involved in the review of proposed residential and commercial developments in a community.

Another reason is that needed fire flows are not always available during the design phase of a water system project. Many other factors also determine actual flows and water main sizes to certain areas. Fire hydrants are also used to flush public water systems and many hydrants have been installed for this sole purpose. Nevertheless, inadequate and unmarked fire hydrants provide a false sense of security to the fire department and property owners.

Correcting Deficient Fire Flows

Reference Number: MTAS-1898

TDEC Rule 0400-45-1-.17(18) provides a fire chief with justification to request improvements in the water system. The regulation does not prevent the fire department from using a deficient fire hydrant (for example to fill tanks), but it does prevent the fire department from using a deficient fire hydrant with the fire apparatus pump engaged, which may result in inadequate fire flows and a poor outcome in firefighting operations (i.e. increased property loss). Once the fire department has identified at-risk areas with deficient water supplies for firefighting, the fire department should request of the water department, and any other departments, agencies, or entities that would be involved in decision-making and funding, a plan to upgrade the water system to provide adequate water for the protection of life and property. An inadequate water supply for fire protection makes it difficult for a community to get a good ISO rating for affordable property insurance rates.

The TDEC regulation provides fire departments with a way to identify hydrants with deficient fire flows so that the fire department does not use the deficient fire hydrant if another hydrant with adequate fire flows is within a usable distance of the fire. The regulation requires that deficient fire hydrants be marked with a red top to denote that the fire hydrant flows less than 500 gallons per minute, thus identifying the hydrant as a deficient fire hydrant for responding firefighters.

Once areas of a community with deficient fire flows are identified, the fire department and water utility should use a cooperative approach to create and implement a plan of corrective action. The common goal for both the fire and water department should be to protect the water system and public health while delivering adequate fire flows to the entire community. Improving the water system can be costly, requiring engineering studies and design work, which takes time. In addition, the utility must find funding sources for the improvements. Therefore, correcting deficient flows will take time, but the sooner everyone develops and approves a plan, the sooner the community will enjoy the benefits of an adequate water supply for fire protection purposes.

Improving the water system, installing larger water mains, replacing older/smaller water mains, and installing fire hydrants is expensive. Smaller communities may be eligible for community development block grants (CDBG) to provide financial assistance in improving the water system for fire protection purposes. This is the link for the CDBG program in Tennessee for more information on these grants: https://www.tn.gov/ecd/community-development-block-grant/cdbg.html [2]

Identifying and Marking Deficient Fire Hydrants

Reference Number: MTAS-1899

For the purposes of marking fire hydrants, a deficient fire hydrant is a fire hydrant that cannot provide a fire flow of at least 500 gpm at 20 psi residual pressure. Deficient fire hydrants (Class C hydrants) must be properly marked and identified. The public also needs to be educated in this area. A typical homeowner who sees a fire hydrant near their home, or a business owner who sees a hydrant near his business, may not realize that the fire hydrant cannot provide enough water to extinguish a fire in the home or business. In addition to giving the homeowner or business owner a false sense of security, inadequate fire flows result in higher property insurance premiums. Most insurance requirements state that adequate water flows must be available within 1,000 feet of structures to get full credit for fire hydrants.

Where fire hydrants are properly marked, most fire departments only connect to a Class C hydrant as a last resort. The fire department needs a reliable water source and according to the Insurance Services Office (ISO) on community water systems, a minimum of 500 gpm is needed to fight a basic residential structure fire. Actually, depending on the distances between structures, the needed fire flow is much higher. ISO also does not recognize hydrants on water mains less than six inches in diameter. Therefore, connecting into a red top hydrant does not supply basic needed fire flows and is only done as a last resort. However, ISO will recognize a fire hydrant in a rural setting as a suction point where tanker shuttles are necessary as long as the hydrant can deliver a minimum flow of 250 gpm at a residual pressure of 20 psi for two hours.

Marking All Fire Hydrants

Reference Number: MTAS-1900

To fight a fire effectively, firefighters must be able to determine hydrant flows immediately upon arrival. Fire hydrants should be immediately recognizable to firefighting forces as well as to the public.

Fire hydrants should be color coded to NFPA Standard 291, *Recommended Practice for Fire Flow Testing and Marking of Hydrants*, 2019 Edition. Color-coded fire hydrants provide an immediate visual indication of available hydrant flow. Without color-coding, firefighters cannot know the flow potential of a hydrant, especially if the firefighters are responding to a mutual aid call.

The hydrant barrel should be chrome yellow unless the jurisdiction has adopted another color for their hydrants (NFPA 291 § 5.2.1.1). Other highly visible colors used by communities include white, bright red, chrome silver, and lime-yellow. In jurisdictions where no standard color has been established, the most important aspect is consistency. Standard colors should be adopted which, preferably, are the same throughout the region.

Paint the top (bonnet) and nozzle caps (discharges) appropriate colors to indicate hydrant capacity (NFPA 291 § 5.2.1.2).

Fire hydrant bonnets and caps shall be coded as follows (NFPA 291 § 5.2.1.2):

COLOR	CLASS	AVAILABLE FLOW @ 20 psi residual
BLUE	AA	1500 GPM or more
GREEN	A	1000-1499 GPM
ORANGE	B	500-999 GPM
RED	C	Below 500 GPM

NFPA recommends using reflective-type paint for easy identification at night (NFPA 291 § 5.2.1.3).

NFPA also recognizes that there are often functional differences in service provided by municipal and private hydrant systems. Therefore, NFPA specifies that non-municipal hydrants be painted a color that distinguishes them from municipal hydrants. Furthermore, violet has been established as the international color code for non-potable water. Therefore, hydrants supplied by non-potable sources should be painted violet (light purple).

The following body colors are recommended for fire hydrants:

Supply	Body Color
Municipal System:	Chrome Yellow
Private System:	Red
Non-Potable System:	Violet (Light Purple)

One of the biggest mistakes made in color-coding a hydrant is the failure to reduce the residual flow pressure to 20 psi. Many departments will color code the hydrant at whatever the flow was without taking time to chart or calculate the actual flow at 20 psi. This requires extra work but can mean the difference in color-coding in up to 50 percent of the hydrants in a given system.

NFPA 291 recommends stenciling the rated capacity of hgh volume hydrants on the top (NFPA 291 § 5.2.1.5).

Flow Test a Fire Hydrant

Reference Number: MTAS-1901

Many fire departments and water utilities do not know how to flow a fire hydrant properly. According to TDEC, there is no state regulation on how to flow a fire hydrant, but TDEC recognizes the American Water Works Association (AWWA) pamphlet # M-17 as the recognized standard for testing fire hydrants. Pamphlet M-17 is what both ISO and NFPA recognize as the approved method for flowing fire hydrants.

According to this standard, the proper way to test a hydrant and water main is to put a cap gauge on the test hydrant and take a static reading. Then proceed down stream to the next flow hydrant and back up stream to the closest flow hydrant and flow both at the same time. Use as many ports and sizes of discharges to make the largest drop in residual pressure. Record the pitot pressure at each flowing port and then record the residual pressure back at the test hydrant.

When the test is complete, five pieces of data will be used in determining the flow of the hydrant: the static pressure, the residual pressure, the flow (pitot) pressure, the size of the outlet flowing water, and the number of outlets open during the test. This information will be converted to gallons per minute by using a calculator or flow chart. The residual pressure will need to be charted to record the flow in gpm at 20 psi.

According to water experts, the multi-hydrant flow test method is the best and most accurate way to conduct a test. Doing single hydrant flow tests (i.e. where one hydrant is used to get the static, residual, and pitot pressures) is one reason so many communities seem to have so many red top hydrants. ISO will not recognize a single hydrant flow test.

MTAS has an Excel spreadsheet that one can use to calculate and document the results of fire hydrant flow tests. This resource is available on the MTAS website at this link: http://www.mtas.tennessee.edu/knowledgebase/fire-hydrant-flow-test-results-calculator [3].

MTAS has a model press release that a community can use to notify residents when fire hydrant flow testing is going to occur. This resource is available on the MTAS website at this link: http://www.mtas.tennessee.edu/knowledgebase/model-press-release-fire-hydrant-inspections-and-flow-testing [4].

MTAS has a model ordinance adopting by reference the NFPA fire hydrant color coding standards and establishing certain standards for fire flows and hydrants and use of some existing fire hydrants. This resource is available on the MTAS website at this link: http://www.mtas.tennessee.edu/knowledgebase/fire-hydrant-ordinance [5].

Protecting Public Water Systems Conclusion

Reference Number: MTAS-1902

We all drink from fire hydrants and share a common goal to protect the water system. When using fire hydrants, fire departments have a responsibility for keeping our drinking water as safe as possible. A coordinated effort between the fire department and water utility is essential in protecting public health. Communities should identify and mark fire hydrants in all areas,and especially in areas with deficient fire flows. Once these deficient areas are identified, every stakeholder should be involved in creating, funding, and implementing a plan of corrective action to provide adequate fire flows to protect life and property. For efficient firefighting operations, communities should mark all fire hydrants in the community according to NFPA Standard 291. Good planning is needed to ensure that the community has adequate fire flows for fire suppression operations. The water supply represent 40% of the community's Insurance Service Office (ISO) rating, and cooperation is essential to meet everyone's interests, to provide the adequate fire flows needed to protect life and property, and to keep the community's drinking water supply safe.

Links:
[1] https://publications.tnsosfiles.com/rules/0400/0400-45/0400-45.htm
[2] https://www.tn.gov/ecd/community-development-block-grant/cdbg.html
[3] http://www.mtas.tennessee.edu/knowledgebase/fire-hydrant-flow-test-results-calculator
[4] http://www.mtas.tennessee.edu/knowledgebase/model-press-release-fire-hydrant-inspections-and-flow-testing
[5] http://www.mtas.tennessee.edu/knowledgebase/fire-hydrant-ordinance

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