Fire Sprinkler Systems - Capacity tests and Public Water Mains

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Abstract

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The purpose of this project is to provide support to local municipalities and other stakeholders on how sprinkler installations connected to the water mains should be installed and maintained so that a high fire safety can be obtained without any inconvenience or disturbances to the municipal water supply. The report includes recommendations for how Swedish municipalities can manage applications for sprinkler connections, and how the sprinkler industry can handle the design, installation and maintenance to minimize the risk for drinking water quality problems.

Key words:
Sprinkler, public water mains, drinking water quality, backflow prevention, sprinkler pumps, capacity test.

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Preface

This report is a summary of the project *Water Sprinkler – Capacity tests and Public Water Mains.* The project was funded by the Swedish Fire Sprinkler Association, FM Global Fire Prevention Grant USA, International Fire Sprinkler Association USA (IFSA) and the Swedish Fire Protection Association. The authors of this report want to thank all the financial contributors and the following persons and organizations who have contributed to the project:

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1 Background

During the last decade, the use of fire sprinkler has increased in Sweden. Fire sprinkler is often used in buildings to lower the requirement of other fire protection measures, and to allow more flexible fire protection solutions. Since 2013, there is also a Swedish code requirement for fire sprinklers in certain care facilities and in hospitals, which will result in a further increase of fire sprinkler installations.

Water for fire sprinkler can be supplied directly from public water mains, or from a storage tank in, or close to, the protected facility. According to the European standard EN 12845, which is also adopted as a Swedish standard, full scale capacity tests should be performed each year. The water suppliers in Sweden are concerned that the following problems might arise during these capacity tests if the sprinkler systems are connected directly to the water mains:

- Improper handling and too quick closing of control valves during testing might cause pressure shocks and bursting of water pipes.
- Too high water flows might release sediments in pipes and cause discoloration of water
- Systems with inadequate pump design might cause negative pressure in pipes, and risk of contaminations being drawn into the pipes.
- Negative pressure might cause bursting of pipes

There are large differences between the municipalities in Sweden concerning if and how sprinkler may be connected to public water mains and if capacity tests are allowed. Some municipalities, e.g. Stockholm, generally allow direct connection and full scale capacity tests. Other, e.g. Gothenburg, allow direct connection and *one* full scale test during system commissioning. After this, only limited capacity testing is allowed, up to a certain specified flow. In Mölndal, direct connection to public water mains are not allowed at all, and all existing sprinkler systems need to disconnect and build separate storage tanks and install sprinkler pumps before 2019.

Considering that the use of sprinkler systems is increasing due to new code requirements, it is desirable to reach a Swedish consensus for how sprinkler water supply should be handled by the water suppliers. In order to achieve this, there are several challenges that need to be resolved, e.g:

- The demand for full scale capacity tests according to SS-EN 12845 to be performed each year. The test should be carried out at a time of maximum demand on the main, so testing cannot be carried out at certain times to reduce the risk of water quality issues.
- Backflow prevention and risk of contaminated water in the water mains.
- Capacity demands and the risk of oversized water mains.

1.1 Purpose

The purpose of this project is to provide support for municipalities and other stakeholders on how fire sprinklers can be installed and maintained so that a high fire safety level can be achieved without causing inconvenience or disturbance for the public water supply.

1.2 Goal

The project goal is to provide a basis and recommendation for how the municipalities of Sweden should handle permission for direct connection of fire sprinkler systems, and how the sprinkler industry should perform design, installation and testing to minimize the risk of drinking water quality problems without compromising the fire safety level. The recommendations should also be a basis for changes in industry recommendations and standards.

1.3 Method

The project was carried out through the following steps:

- Interviews with representatives from different municipalities water suppliers, sprinkler designers, contractors, sprinkler industry organizations, insurance companies and governmental agencies to identify problems and conflicts in interest.

- Literature study of current legal acts, regulations, standards and recommendations to clarify the legal responsibilities, and opportunities to improve the regulations to minimize the actual problems and sort out any misunderstandings.

- Market survey to identify technical solutions to minimize problems.

Two workshops have been held during the project, with stakeholders from the sprinkler industry, the insurance industry, water suppliers, governmental agencies and representatives from the municipalities.

2 Municipality policies

This chapter gives a description of policies in different municipalities in Sweden. A less detailed compilation of 25 more municipalities is also given.

The compilation was made through research on each municipality website, and through telephone interviews or email correspondence for some of the municipalities. Primarily, municipalities that were known to have introduced limitations of fire sprinkler connection were contacted. Large municipalities with many fire sprinkler systems connected to the water mains were also chosen. These were identified with help from the project reference group. Additional municipalities were chosen based on population size and geographical location to be able to identify difference based on these conditions.

2.1 Gothenburg

In Gothenburg, direct connection to water mains is generally allowed, given that sufficient capacity is available at the specific location. When a sprinkler connection is requested, a capacity survey is performed by hydraulic calculation and/or simulation in the software Mike Urban. In some rare cases, this is supplemented with a small scale flow test at the location. The capacity survey is compiled and sent to the client, and a contract for the sprinkler connection is established between the client and the water supplier.

One full scale capacity test is allowed during the system commissioning. Further full scale capacity tests are only allowed if it will not affect the water quality in any way. The terms are set by the water supplier in the contract, and include that:

- The flow rate may not exceed 1.3 m/s in the water main.
- For sensitive areas, the flow rate may not exceed the normal maximum flow rate.
- Rinsing of the water mains is required after a capacity test. This applies for all areas.
- Technicians from the water supplier need to be present at all times during capacity tests

2.2 Mölndal

In 2009, Mölndal decided that all new fire sprinkler connections should be made with a separate storage tank and sprinkler pumps. Additionally, all existing fire sprinkler systems (about 20 systems) are required to disconnect from the water mains and install a separate storage tank and sprinkler pumps before 2019.

The reason given for the decision was that capacity testing or activation during fires might cause disturbances for the water quality:

- The sprinkler owners do not ask the water supplier before tests are made, which lead to depletion of the water reservoir and other customers are left without water.
- Fire or capacity tests give a high flow in the pipes that causes sediments in the pipe to come off, which lead to contaminated water in the water mains and to other customers.
- The water mains are not designed for fire sprinkler systems.
- When the sprinkler system is used during fire or capacity testing, a pump will start that draws water from the water mains, creating a negative pressure in the pipes that can lead to leakage. (See chapter 3.2 Misconceptions)

Another reason mentioned is additional costs for the water supplier, due to reconstruction of the water mains if the capacity is insufficient, and due to increased maintenance of leaking or bursting pipes.

2.3 MittSverige Vatten

MittSverige Vatten, the water supplier for the municipalities of Sundsvall, Timrå and Nordanstig, published a new policy on their website in January 2015:

New fire sprinkler systems
Direct connection to water mains is not allowed. Connections are only allowed through separate storage tanks with full capacity for the water demand. The storage tank must be connected through an air gap. The primary reason for this is the risk of quality problems. Stagnant water in the sprinkler pipes might flow backwards to the water mains during a water leak, and contaminate the water supply.

Existing fire sprinkler systems
An inventory of all existing fire sprinkler systems will be made during the first six months of 2015. New contracts are to be set up with all sprinkler customers, including costs and requirements for backflow prevention. Without backflow prevention, MittSverige Vatten has the right to shut down the connection. This is also applies if the client cannot show yearly checks of the backflow prevention.

2.4 Luleå

Luleå do not allow direct connection of fire sprinkler systems. The reason given for this is a lack of capacity. Connections with storage tanks and sprinkler pumps are allowed.

2.5 Stockholm

In Stockholm, direct connection of fire sprinkler systems is generally allowed, given that sufficient capacity is available, which is usually the case with only a few exceptions.

Full scale capacity tests are allowed, with technicians from the water supplier present, since they are the only ones allowed to handle the main control valves. In some areas where there has been issues with the water quality due to testing, flow limitations during tests has been set. Due to the high number of fire sprinkler systems in the city, some technicians work full time with capacity tests during some time periods.

Backflow prevention of at least class EA according to the standard SS-EN 1717 is mandatory, given that no materials that might cause lead or zinc contamination are used in the system. If this risk is not negligible, backflow prevention of a higher class is needed.

2.6 Compilation of other municipalities

A compilation of about 30 municipalities, including the ones mentioned above, is given in Table 1. The choice of municipalities was made to get a distribution of different population sizes and geographical location, see Figure 1 and Figure 2.

Table 1 – Compilation of municipalities

Kommun	Population [1000 inh.]	Is direct connection allowed, given sufficient capacity?	Source
Borlänge	51	Yes	Phone interview
Borås	107	Yes	Website info
Gävle	98	Yes	Phone interview
Göteborg	541	Yes	Phone interview
Halmstad	96	Yes	Website info
Helsingborg (NVSA innefattar även Bjuv, Båstad, , Landskrona, Svalöv och Åstorp)	135	Yes	E-mail correspondence
Härjedalens kommun	10	Yes *	Website info
Höör	16	Yes **	Phone interview
Jönköping	132	Yes	Website info
Karlstad	88	Yes	Website info
Linköping	152	Yes	Website info
Luleå	76	No	Website info
Lund	116	Yes	Website info
Malmö	318	Yes	Website info
Mitt-Sverige-Vatten (Sundsvall, Timrå och Nordanstig)	125	No ***	Phone interview
Mölndal	63	No	Phone interview
Nyköping	54	Yes	Website info
Region Gotland	57	Yes	Website info
Skövde	53	Yes	E-mail correspondence
Stockholm	910	Yes	Phone interview
Umeå	120	Yes	Phone interview
Växjö	87300	Yes	Phone interview
Örebro	143339	Yes ****	Phone interview
Östersund	60763	Yes	Website info
* Generally, a separate storage tank is prefered			
** Do not have any stated policy for sprinkler connections, very few systems today.			
***According to telephone interview with the Security Manager, the policy might be changed if the sprinkler standards are revised to better handle the risks for the water quality.			
**** The municipality is currently working on an updated policy.			

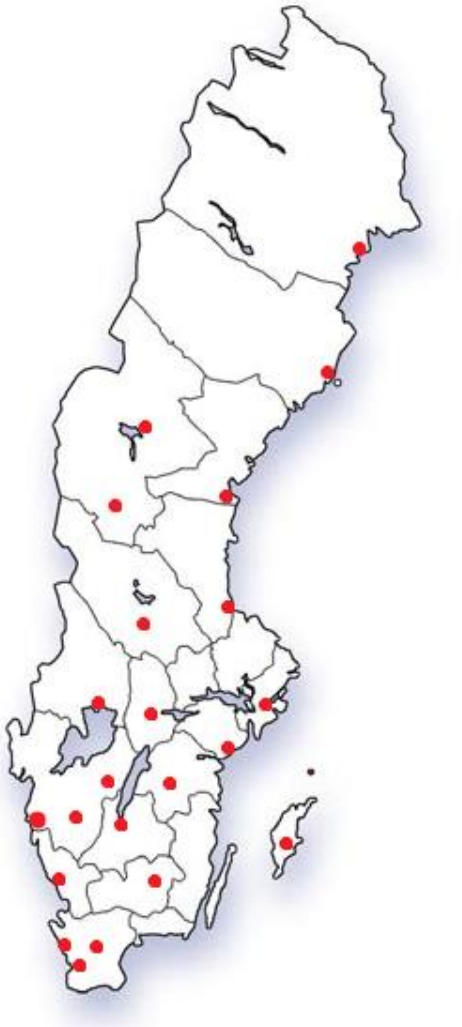

Figure 1 Geographical location of the surveyed municipalities.

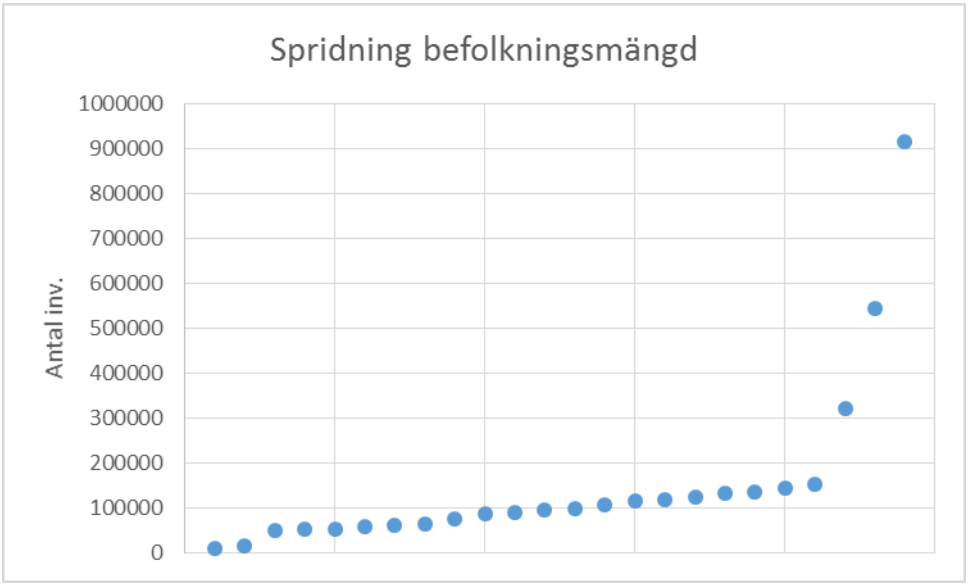

Figure 2 Population of the surveyed municipalities.

Only three of the surveyed municipalities prohibit direct connection of fire sprinklers at present. However, each municipality states that sprinkler connections are not a mandatory service that need to be provided by the water supplier. An assessment should be made for each individual case, regarding available capacity and the risk of disturbances in the water mains.

The policy regarding capacity testing vary between the municipalities according to the following:

- No general limitations
- Request and approval from the water supplier before tests are made
- Testing is only allowed certain week days or certain times during the day
- Flow limitations
- Supervision or execution of the tests by water supplier technicians.

A combination of more than one of the above might also be the case. The view of the capacity tests also varies, where some see synergies and benefits with participating during the tests, while others feel that they take up too much time from the normal operations.

The general requirements for backflow prevention is class BA according to SS-EN 1717, with an exception of Stockholm that require the lower class EA as a minimum.

3 Actual problems and misunderstandings

In this chapter, actual problems that have occurred due to direct connections of sprinkler systems are described. The incidents have not documented in incident reports, and are based on the interviews made with the water suppliers. Different misconceptions, and risks that should not be a real problem given that current standards are followed, are also described.

3.1 Actual problems

High flows can cause sediments in the pipes to come off, which lead to discoloration of the drinking water.

- This is the single most common problem that most water suppliers, and people performing capacity tests, mention. When a full scale capacity test is performed, the flow rate is so high that sediments that have been built up for some time is drawn loose. Even if the test continues until clean water comes out where the test is made, there is a risk that discolored water has spread further to other costumers. This leads to customer dissatisfaction and extra work for the water suppliers, see Figure 3..

Figure 3 – Discolored drinking water is the most common problem caused by direct connection of fire sprinkler systems to the water mains.

Oversized pipes and too low flows might also be an issue.

- Large pipes with too low flows and a slow turnover of the water can also lead to drinking water quality issues. Due to this, some municipalities do not wish to guarantee a certain flow rate for sprinkler systems, since that might limit the possibilities of reducing the pipe sized in the future to reduce the problems.

Pipe bursts might happen due to pressure shocks.

- This does not seem to be a common problem, but might happen during testing if control valves are not handled properly. If people with proper training handles the valves, or if technicians from the water suppliers are present during testing, the risk can be minimized.

During capacity tests, much higher flows than required are taken out.

- This seems to be a quite common problem, and it is an entirely unnecessary risk for the water quality. To test for flows up to three times as high as the maximum demand is not acceptable since it increases the risk of discolored water significantly.

Capacity tests take up too much time from the water suppliers.

- This is starting to become a problem in the larger municipalities of Stockholm and Gothenburg, due to the large number of sprinkler systems.

There are no drains to handle all the water that is flushed out during tests.

- In many systems, the water is flushed directly out to the street, and further to the storm water drains. This can lead to icy streets and traffic problems during cold days.

3.2 Misconceptions

Sprinkler pumps draw water from the pipes and create a negative pressure so that contamination can be drawn into the pipes.

- Most systems are designed without pumps, which cannot cause negative pressures regardless of how large flows are taken out. The risk is only relevant for a large pump that has not been designed, installed or been commissioned according to applicable standards, that require a remaining pressure of at least 0,5 bar for 120% of the maximum demand flow. Previously, this margin was 1 bar in Sweden, but was lowered due to harmonization with the European standard. However, a water supplier does have the right to require higher margins where it is considered necessary.

Sprinkler water contain toxic foam liquid.

- A few sprinkler systems, mainly for industrial facilities, contain a mixture of foam liquid. However, this is only applicable for a small fraction of all sprinkler systems. All other systems are conventional systems that only contain ordinary water.

In case of fire, all sprinkler will activate at once, and the water flow is just as high as when doing a full scale capacity test. .

- In most fires, only 1-4 sprinkler heads will activate, that either extinguish the fire, or control the spread of the fire so that no more sprinkler heads will activate. Certain risk environments might have deluge sprinkler systems, with open sprinkler heads where an entire section will activate at once, but just as with foam sprinklers, these are only a small fraction of all sprinkler systems. every sprinkler head will activate in case of fire, , there are deluge sprinkler systems. One reason for this misconception might be that far to many TV series and Hollywood movies show this incorrect image, where a lighter held underneath a smoke detector or a sprinkler head activates the sprinkler system in an entire building, see Figure 4.

Figure 4– Activation of the entire school sprinkler system, from the movie Mean Girls.

Activation in case of fire, or capacity tests, will deplete the water reservoir.

- The amount of water used during a capacity test usually varies between 500-4000 l/min during a total of 5-10 minutes. This gives a total volume of approximately 2,5 -40 m^3. These values are valid for systems ranging from residential sprinklers up to sprinklers for a shopping mall. If testing is performed correctly, this should not be a problem for the water reservoir. As stated earlier, most fires are controlled by 1-4 sprinkler heads, and is shut off after 20-60 minutes. An approximate water use in case of fire would range between 2-35 m^3 For the systems mentioned above. The total user of water could even be much higher if no sprinklers are installed, since more water would be needed by the rescue service to extinguish the fire.

4 Additional costs for municipalities if direct connection of sprinkler is prohibited

The Swedish municipalities are responsible for some of the facilities with code requirements for sprinkler systems. These include retirement homes and different sorts of assisted living. In total, it is approximated that there are 5 000 facilities that are subject to the code requirement for residential sprinklers type 3, which was introduced in 2013. This corresponds to 5,13 facilities per 10 000 inhabitants in Sweden.

The additional cost of installing a residential sprinkler system of type 3, if the public water mains cannot be used as a direct source, consist of two parts:

1) Plastic tanks with a total volume of 15 m^3 and a double pump set, estimated cost of 380 000 SEK for material and work.
2) Extra building of 20 m^2 to house the equipment, with a standard building cost of 27 000 SEK/m^2, estimated total cost 540 000 SEK

This sums up to 920 000 SEK per facility, or a total cost of 4,7 million SEK per 10 000 inhabitants, for all facilities in a municipality. The estimation might of course vary depending on specific conditions, e.g. if there is an existing are to place equipment. The cost for pumps and water tanks is less unsure, since the requirement is residential sprinklers type 3 with a limited range in water demand.

Additionally, all sprinkler systems need maintenance and testing regularly. A type 3 residential sprinkler require weekly pressure gauge checks. If the system has a pump, this also require a weekly test run, which is more time consuming than to only check pressure gauges. The maintenance and testing costs will therefore be higher compared to a system directly connected to the water mains. The additional time is estimated to be 1-4 hours, depending on if there are internal resources to conduct the tests, or if external help is needed, and also the amount of travel time to the facility. With an hourly rate of 500 SEK/h. the additional costs are estimated to 25 000-100 000 SEK per year, or 130 000-510 000 SEK per year and 10 000 inhabitants in a municipality.

As stated earlier, local conditions might give lower or higher costs. Some facilities already have sprinkler systems, and other might have an existing space to place the equipment. Also, the code requirements are not retroactive, and will come into force first when a major remodeling is performed. This means that the cost will be spread out during a time period of 40-50 years, which is an established life span of a building.

Other aspects to consider is that other facilities without code requirements might want to install sprinkler systems for other reasons. Given that other, similar municipalities, allow direct connection of sprinkler systems, a prohibition of direct connection to water mains might make the municipality less attractive to companies, which can lead to missed job opportunities and tax revenue. However, this effect is very difficult to estimate.

5 Legal Acts, Regulations, Standards and Recommendations

This chapter gives a brief review of the legal acts, regulations, standards and recommendations concerning sprinkler systems and public water mains, in order to:

- Clarify responsibilities
- Identify existing requirements that minimizes the risk for water quality problems
- Identify requirements that cause conflicts
- Identify missing requirements that could reduce the risk for water quality problems.

5.1 Legal Acts

5.1.1 Civil Protection Act (2003:778)

The purpose of this act is to protect the lives and health of people, and also property and the environment, against accidents. According to the Act, owners or users of a building are the ones responsible for providing equipment for fire extinguishment, and for measures to prevent fire, and prevent or limit damages due to fire.

5.1.2 Public Water Supply Act (2006:412)

The purpose of this Act is to ensure that water supply and sewage is arranged where necessary for the protection of human health or of the environment. Water supply is defined as water that is suitable for normal household use. However, when compatible with the water and sewage systems' main purpose, it should be organized so that other public interests that need the facility can be met.

The preparatory work for the Act also includes comments regarding water for sprinkler systems, stating that it should not be seen as a mandatory service that water suppliers are required to offer. However, it is also stated that it is assumed that water suppliers should be inclined to offer the service in cases where the technical conditions can be met.

5.2 Regulations

5.2.1 The Swedish Building Regulations, BBR

BBR contain mandatory provisions and general recommendations on how the requirements in the planning and building act and the planning and building ordinance can be fulfilled. Chapter 5 handles safety in case of fire, and chapter 6 handles hygiene, health and environment.

Residential sprinkler systems are required for occupancy class 5B (special accommodation for people with disabilities, physical or mental illness, and similar). Automatic water sprinkler system is required for occupancy class 5C (hospitals).

The provisions require that installations are designed so that the water quality and the hygiene conditions satisfy general health requirements.

5.2.2 SLVFS 2001:30 NFA regulations on drinking water

The regulations apply to the handling of and quality of drinking water. Drinking water supplied or used as part of a commercial or public activity is always covered by the rules, no matter the size. The regulation demands that drinking water shall be wholesome and clean, and specifies the quality requirements to be met.

5.3 Standards and recommendations

5.3.1 SS-EN 12845 Fixed Firefighting systems – Automatic sprinkler systems – Design, installation and maintenance

This European standard is adopted as a Swedish standard and specifies requirements and provides recommendations regarding the design, installation and maintenance of fixed fire sprinkler systems in buildings and industrial plants, as well as special requirements for sprinkler systems, which are integral to measures for the protection of life. The standard specifies, among other things, the capacity requirements for connecting to a public water main, as well as how and when the capacity tests should be carried out.

5.3.2 SS 883001/INSTA 900-1 Residential sprinkle systems – Design, installation and maintenance

This standard specifies requirements and recommendations for the design, installation and maintenance of fixed residential sprinkler systems in buildings or parts of buildings used as residences.

5.3.3 SS-EN 1717 Protection against pollution of potable water in water installations and general requirements of devices to prevent pollution by backflow

This standard handles measures to protect against contamination of drinking water, and general requirements of devices to prevent pollution by backflow, and specifies the minimum requirements of product standards for the protection equipment. Swedish waters have drawn up a guide for the application of the standard, VAV P88.

The standard divides liquids into five different categories based on the health risk they pose. Requirements for backflow protection is then based on the liquid classification, and the prevailing pressure conditions.

5.3.4 SBF 120 Regler för automatiskt vattensprinklersystem

The regulation specifies requirements for the design, installation and maintenance of sprinkler systems and shall be applied in conjunction with EN 12845. The regulation contains clarifications on how EN 12845 shall be applied and additional specific Swedish requirements.

5.3.5 SBF 501 Regler för boendesprinklersystem

The regulation specifies requirements for the design, installation and maintenance of residential sprinkler systems and shall be applied in conjunction with SS 883001. The regulation contains clarifications on how SS883001 shall be applied and additional specific Swedish requirements.

5.3.6 SBF 142 Anvisningar för anslutning av vattensprinklersystem till allmänt vattenledningsnät

The document specifies the appropriate requirements and conditions when connecting a water sprinkler system to the public water mains. The overall objective is to enable the use of sprinkler systems for fire protection purposes while protecting the water quality.

5.3.7 VAV P76 Vatten till brandsläckning

The purpose of this publication, which was published in 1997 by the Swedish Water and Wastewater Association, is to address key issues regarding the use of water from the public water mains for firefighting purposes.

5.4 Analysis of Legal Acts, Regulations, Standards and Recommendations

It is clearly stated that public water suppliers do not have a mandatory requirements to provide water for fire sprinkler systems. When the technical conditions can be met, without causing any disturbances, it is a service that should be provided.

The technical conditions that must be considered are that the existing water main has sufficient capacity to supply the sprinkler system, and that the sprinkler system is designed, installed and maintained so that any inconvenience, such as impaired drinking water quality, is avoided. If the technical conditions can be met, the service should be provided.

Design, installation, and maintenance of sprinkler systems are regulated by a comprehensive standardization, complemented by industry recommendations. Further, mandatory certification is required for designers, installers, inspection agencies and inspectors. Therefore, there is a quality system in place to ensure that the final system will meet the agreed requirements.

For some parts concerning the protection of water quality, there is room for a number of improvements. Above all, the requirement for yearly capacity tests, with an additional margin of 50 %, is causing the most common problem for the water suppliers. The tests cause a risk for discoloration of the water, and also take up a lot of time for the water suppliers to plan and execute. Better knowledge of the risks should also be a mandatory prat of the certification of inspection firms and inspectors. Technical and organizational measures to improve the possibilities to connect sprinkler systems the water mains, while minimizing the risk for water quality problems, is given in chapter 6.

How water in sprinkler systems should be classified is unclear, and therefore, the requirements for back flow prevention is uncertain. Due to the precautionary principle, most municipalities require back flow prevention of class BA, which causes a relatively high pressure drop. If the risk is overestimated, it might lead to unnecessary costs, since pumps need to be installed to compensate for the pressure drop.

6 Technical and organizational measures

This chapter describes the various technical and organizational measures that could be introduced to minimize the risk of inconveniences caused by direct connection of sprinkler systems to the water main.

6.1 Limited capacity tests

The requirement for full scale capacity tests to be performed each year is the single biggest reason that inconvenience occurs on the pipeline. To minimize this problem, Gothenburg has introduced limited capacity tests, where the maximum water flow is determined from a maximum flow rate of 1.3 m / s in the pipes. In Norway, a large number of municipalities have applied limited capacity tests for several years as well.

Experiences from a project conducted in Norway shows that limited capacity tests in combination with hydraulic calculations can provide the same results as a full scale capacity tests, provided that the water source is a level tank [8]. Booster pumps and valves on the pipeline might complicate the calculations, and require a good knowledge of the system to get accurate results in these cases.

Although a limited capacity test does not give a complete answer of the water main capacity, it is still enough to be able to identify changes or deviations from the original tests carried out at the system commissioning. For example, closed or half-closed valves can be detected in this way. By carrying out limited capacity tests more frequently, a better reliability of the water source can be achieved, while problems with the water quality can be minimized.

Another option is to allow that systems connected to a ring fed water main is tested with open inflow from both directions, which reduces the flow rate in the network and thereby reduces the risk for water quality problems. NFPA's regulations for sprinklers allow that testing is performed in this way, so this approach could be taken in Sweden as well.

6.2 Pump testing

To only allow limited capacity tests will cause problems for systems with sprinkler pumps, since they are required to be tested for full flow capacity. For a system without a separate water supply, a smaller tank can be used to circulate water through the pump. This approach is already used by pump manufacturers, where a tank of 6-7 m^3 is sufficient to circulate flows up to 15 000 l/min. For a flow of 1 500 l/min, a tank of 3-4 m^2 is estimated to be sufficient. The water is introduced in the back of the tank, that has two separate compartments so that the water flows over to the second compartment to avoid whirlpools that might cause cavitation. A vertical drop of a couple of meters is sufficient to achieve an overpressure at the pump inlet, and the pressure flow curve will be moved parallel due to the difference in inlet pressure compared to the pressure in the water main.

A detailed design of this solution is not given in this report, and should be designed with help from pump manufacturers when needed.

6.3 Valves or flowmeters with pre-set flows

Test equipment with preset values for capacity testing can be used to ensure that the flow limitations set by the water supplier is not exceeded. An alternative is to, parallel to the fixed water meter (according sprinkler rules normally DN100 for flows up to 4000 l / min) install a smaller water meters (DN65) to limit the flow. Full scale capacity tests are performed during system commissioning, and in the event of abnormal findings at the annual test with the smaller water meter.

This is a simple measure that minimizes the risk of high flows and contamination of the water in the mains during testing.

6.4 Better routines for testing

To clearly show the maximum flow that a sprinkler system is designed for, and any limitations of the capacity test flow specified in the agreement with the water supplier, the pump house, or the control valve sets, should have signage with this information. The consequences for not following these restrictions should also be stated on the signage.

The requirements for certification of inspection agencies and inspectors should be supplemented to include knowledge of the risks for water quality that a sprinkler installation might introduce. With increased requirements for procedures, checklists, internal training and self-control during capacity tests, there is great potential to reduce the risks for water quality problems. Violation of the restrictions from the water suppliers should also be a cause for withdrawal of certificates.

6.5 Water tests to decide classification

There are very few studies made regarding assessment of sprinkler water classification according to the standard EN 1717. Stockholm Water conducted a small study of the water quality for 5 sprinkler systems in 2005 [9]. Examined buildings ranged from restaurants, theatres, warehouses and hotels, built in the period from 1920 to 2005. The age of the sprinkler systems is not clear from the investigation. The study gives the recommendation to classify sprinkler water as category 3 or 4 if the materials used in the system can cause lead or zinc pollution. If shown that this risk is negligible, the water can be classified as category 2.

Since the choice of material in the sprinkler system, and how often the water is exchanged, can affect the water quality, it would be desirable to make a more comprehensive and systematic study of this. For example, it could be shown that the right materials and a water exchange every three months, is sufficient to ensure that water does not need to be classified higher than category 2. This would mean that a back flow prevention of Class EA is enough, which in some cases would mean a smaller pressure drop, and no need for sprinkler pumps.

7 Proposed changes in sprinkler recommendations

In this chapter, changes in the Swedish sprinkler recommendations SBF 120 is given, based on the actual problems that have been identified. The purpose of the changes is to:

- Allow the possibility of limited capacity tests where the water supplier do not allow full scale testing. This is compensated by shorter intervals between the tests.
- Make sure that the persons performing the tests are well aware of the risks for water quality problems.

These changes will increase the water suppliers confidence in how the tests are performed, and that the maximum flow will not exceed the specified limits.

The following information should be added to the chapters in SBF 120:

8.6 Capacity testing

- Persons performing the capacity tests should have special training for the task
- Before tests are conducted, the maximum flow demand and the maximum allowed flow during tests need to be agreed on in consultation with the water supplier
- Water suppliers should be asked for permission, and invited to participate in the capacity test, before the test is performed.
- The results of the tests shall be documented, with information that show
    - Participants
    - Time / date
    - Maximum allowed water flow
    - Maximum flow demand
    - Continuous flow to ensure that any contamination of the water has been rinsed out.

If shown that the water supply has good reliability, and difficulties prevent the possibility of full scale capacity testing, the AHJ can allow that limited capacity tests are performed to ensure the water supply.

Limited capacity tests.

If the water supplier believe that a full scale test might cause problems for the water quality, the intervals for capacity tests, or the maximum flow during the tests, can be decided by the water supplier.

Limited capacity tests should always be assessed and approved by the AHJ in consultation with the water supplier. Example of a limited capacity tests is when a test is performed with two-side water supply for ring mains, or when the maximum flow rate is limited. This test can be assessed by comparing to an initial test performed during the system commissioning.

The interval for capacity tests can be increased up to every 5 years, if the water supply is

10.7 Pressure and flow demand for sprinkler pump

If the flow during capacity tests is limited, pumps should be provided with a water tank for circulation of water to test the pump capacity according to the maximum flow demand for at least 20 minutes.

18.2 Signage

Water meters should be provided with a laminated sign showing:

Date when the sign was prepared
Who has prepared the sign (company and responsible engineer)
If the system is connected to a ring main or a single supply main
Maximum flow demand for the system
Limitations for water flow during tests, if applicable
Reasons for limitations, if applicable
Instructions that a test should be finished with two-side flow (if connected to ring main), and continuous flow until no contamination of the water can be seen.

The sign shall be updated in case of any changes in the system.

At backflow prevention device, a laminated sign should be provided showing:

8 Suggestion for general municipality policy

In this chapter, a suggestion of a general policy and routine for connection of sprinkler systems is given, based on the policy in Gothenburg. The general purpose is to allow sprinkler connections where sufficient capacity is available, and where the connection can be made without risk of causing problems for the water quality. Residential sprinkler systems should generally be allowed, since the flow demand is in the same order as a normal water consumption. However, exceptions might exist.

Routine for sprinkler connection and capacity tests

This procedure applies when a request for sprinkler connection is received. The procedure also applies to requests for capacity testing, when the current pressure and flow to the existing sprinkler demand is requested.

Scope

This routine describes how the capacity investigation will be conducted, how the request for sprinkler connection is processed, how XX responds to requests for capacity testing and the requirements and limitations for the sprinkler system.

Responsibility, quarantee and safety

XX are not required to allow sprinkler connections.

XX assists with information regarding capacity and possible supply routes. The client, or the person who requires it, decides if the capacity is sufficient. Pressure and flow cannot be guaranteed at all times, even if a capacity test show sufficient pressure and flow at a certain time.

Procedure for request of new sprinkler system connection

1. Request

Questionnaire and map template is sent to client.

2. Capacity investigation

Client specifies location for sprinkler connection, and flow and pressure demand for the system. A capacity investigation is performed by XX using hydraulic calculations or flow simulations. In cases where insufficient data is available, a capacity test is performed. The client is informed that one full scale capacity test is allowed during sprinkler system commissioning. After that, further testing is only allowed if they do not affect the water quality. If this is not acceptable for the client, the alternative for them is to install a separate storage tank and sprinkler pumps.

3. Capacity tests

After the first capacity test during the sprinkler system commissioning, capacity tests are allowed up to a maximum flow deemed not to affect the water quality. The maximum flow should be specified in the contract between XX and the client.

Before each capacity test, a request for permission must be sent to XX. If needed, a technician from XX should be present during the test.

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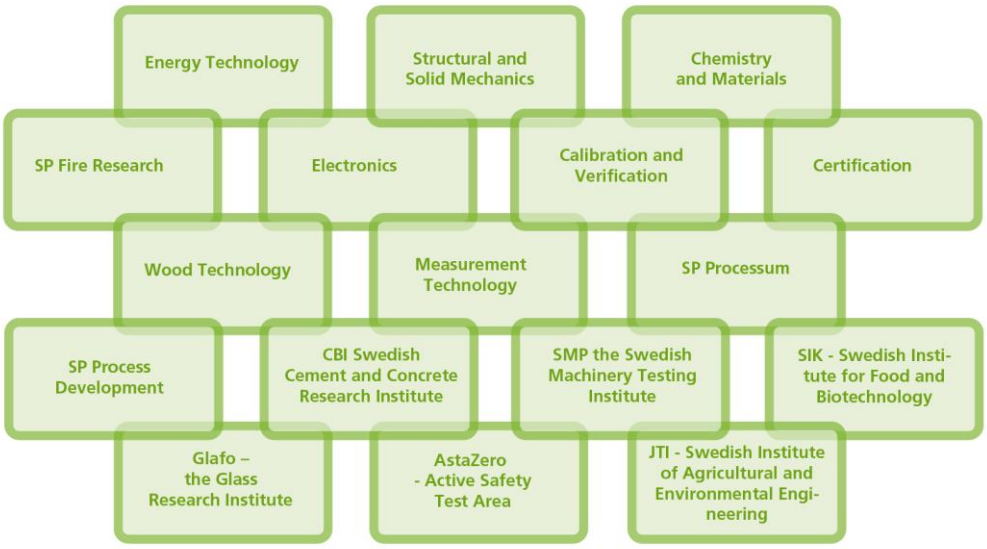

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