Università degli Studi di Ferrara

Università degli Studi di Ferrara
via Ariosto, 35 • 44121
Ferrara
urp@unife.it
Tel. +39 0532 293111
www.unife.it

CONCORSO PUBBLICO, PER ESAMI, PER LA COPERTURA DI N. 1 POSTO DI CATEGORIA C, POSIZIONE ECONOMICA C1, AREA TECNICA, TECNICO-SCIENTIFICA ED ELABORAZIONE DATI PER L'UFFICIO MANUTENZIONE – PROFILO 2 PRESSO L'UNIVERSITA' DI FERRARA.

ELENCO DOMANDE PROVA ORALE

GRUPPO DOMANDE N. 1

1. Si consideri il sistema di circolazione di un impianto di riscaldamento in cui la pompa è in avaria ed è necessaria la sostituzione. Quali sono i parametri di cui tenere conto nella scelta di una pompa equivalente?
2. Viene rilevato un consumo anomalo di acqua in un edificio. Quali possono essere le cause?
3. Utilizzando AutoCad, calcola l'area del locale indicato dalla commissione.
4. Legga ed interpreti il contenuto del testo in inglese fornito dalla commissione.
5. Viene segnalato che da un soffitto gocciola dell'acqua, quali azioni intraprende?

GRUPPO DOMANDE N. 2

1. Si consideri uno scambiatore di calore ad acqua. Se la temperatura del fluido è la stessa in entrata ed in uscita, cosa può significare?
2. In un servizio igienico è presente un forte cattivo odore. Quale può essere la causa e quali prove si possono effettuare per identificarla?
3. Utilizzando AutoCad, calcola il volume del locale indicato dalla commissione.
4. Legga ed interpreti il contenuto del testo in inglese fornito dalla commissione.
5. Durante l'orario di lezione una portineria segnala che da un servizio igienico esce acqua da un WC e che l'acqua ha raggiunto l'atrio. Quali azioni intraprende?

GRUPPO DOMANDE N. 3

1. Si consideri un impianto di raffrescamento composto da un'unità interna ed un compressore esterno. L'impianto sembra in funzione ma non raffresca. Cosa può essere successo?
2. Sul soffitto di un locale è presente una grossa macchia di umidità. Da cosa può dipendere e quali prove si possono effettuare per individuarne la causa?
3. Utilizzando AutoCad, rileva la distanza tra due locali indicati dalla commissione.
4. Legga ed interpreti il contenuto del testo in inglese fornito dalla commissione.
5. Durante il periodo invernale si rileva una copiosa perdita di acqua dalla valvola di un radiatore. Quali azioni intraprende?

GRUPPO DOMANDE N. 4

1. Si consideri una caldaia a gas ad uso riscaldamento in blocco a causa di una sovratemperatura. Quale può essere la causa?
2. In una tazza del WC, posta al piano primo di un fabbricato, il livello dell'acqua rimane alto. Da cosa può dipendere e quali prove si possono effettuare per individuarne la causa?

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3. Utilizzando AutoCad, rilevare la distanza tra un servizio igienico e la prima uscita di sicurezza.
4. Legga ed interpreti il contenuto del testo in inglese fornito dalla commissione.
5. Viene segnalato un forte odore di gas metano in un laboratorio. Quali azioni intraprende?

GRUPPO DOMANDE N. 5

1. Si consideri un'Unità di Trattamento Aria preposta al riscaldamento di un'aula. Nell'aula sono presenti una bocchetta di adduzione ed una di estrazione dell'aria. A seguito di un intervento da parte di una ditta manutentrice, il sistema non riesce più a garantire la temperatura impostata. Cosa può essere successo?
2. In un laboratorio viene acquistato uno strumento che scarica acqua chiara a perdere. In quale modo è possibile smaltirla avendo un lavandino presente nelle vicinanze?
3. Utilizzando AutoCad, misurare la superficie vetrata di un locale indicato dalla commissione.
4. Legga ed interpreti il contenuto del testo in inglese fornito dalla commissione.
5. Da un pozzetto esce acqua chiara che si diffonde sul marciapiede. Quali azioni intraprende?

GRUPPO DOMANDE N. 6

1. Quali terminali di impianti di riscaldamento conosce per riscaldare un locale? Quali sono i vantaggi e gli svantaggi di ciascuno?
2. Viene richiesto di adibire un locale ad uso cucina. Una parete del locale confina con un servizio igienico: è possibile soddisfare la richiesta? Quali aspetti vanno tenuti in considerazione?
3. Utilizzando AutoCad, rilevare l'altezza della colonna di scarico del servizio igienico indicato dalla commissione.
4. Legga ed interpreti il contenuto del testo in inglese fornito dalla commissione.
5. L'indicatore di temperatura, a lancetta, di un boiler elettrico rileva una temperatura superiore a 90°C e si rileva inoltre un rumore di acqua in ebollizione. Quali azioni intraprende?

IL PRESIDENTE DELLA COMMISSIONE
Prof. Guido Zavattini
Firmato digitalmente

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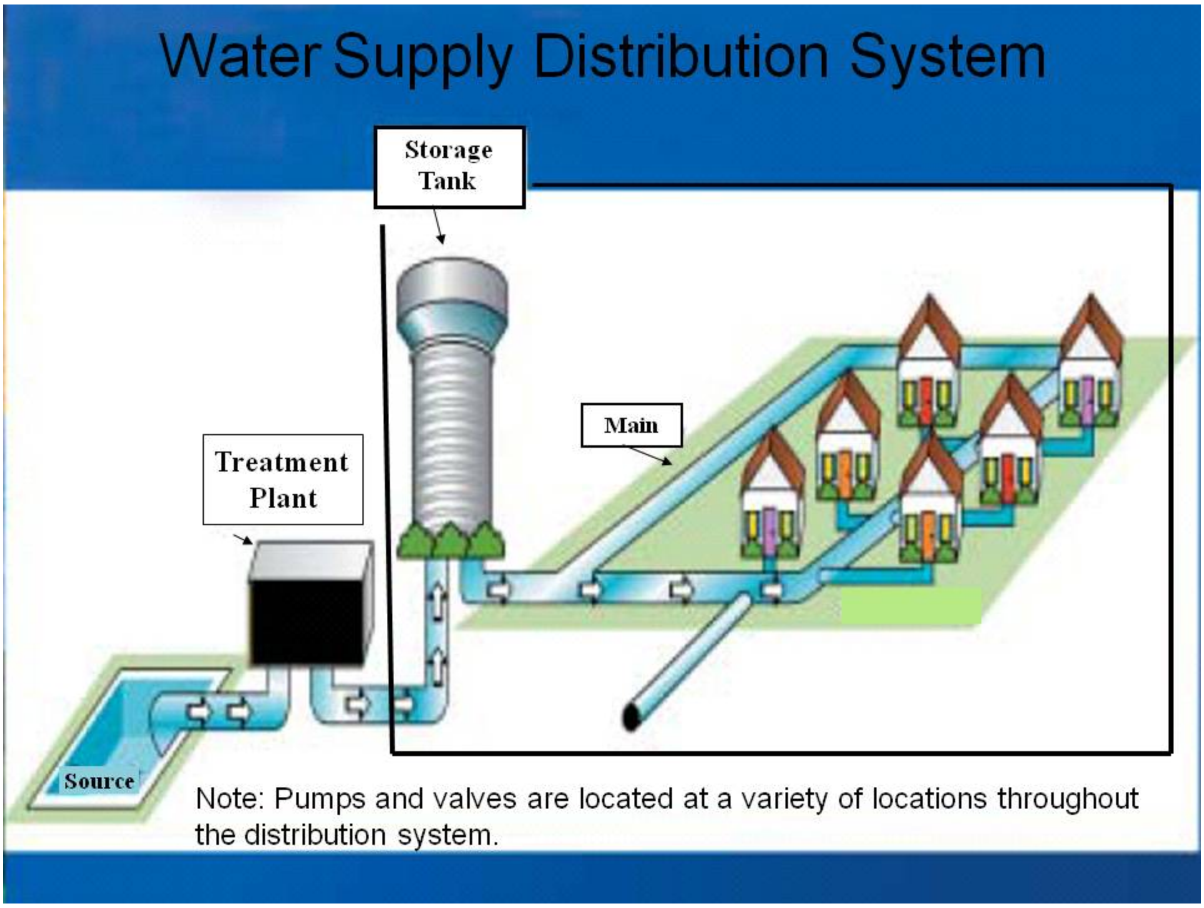
Drinking Water Distribution Systems



Water distribution systems consist of an interconnected series of components. They include:

- pipes
- storage facilities
- components that convey drinking water

Water distribution systems meet fire protection needs for:

- cities
- homes
- schools
- hospitals
- businesses
- industries
- other facilities

Public water systems depend on distribution systems to provide an uninterrupted supply of pressurized safe drinking water to all consumers. Distribution system mains carry water from either:

- the treatment plant to the consumer; or
- the source to the consumer when treatment is absent.

Distribution systems span almost one million miles in the United States. They represent the vast majority of physical infrastructure for water supplies. Distribution system wear and tear can pose intermittent or persistent health risks.

Water quality and the distribution system

New pipes are added to distribution systems as development occurs. The additions result in a wide variation in:

- Pipe sizes
- Materials
- Methods of construction
- Age within individual distribution systems and across the nation

As these systems age, deterioration can occur due to corrosion, materials erosion, and external pressures. Deteriorating water distribution systems can lead to:

- Breaches in pipes and storage facilities
- Intrusion due to water pressure fluctuation
- Main breaks

Documents about distribution system problems and recommendations on reducing risk

Read the support documents:

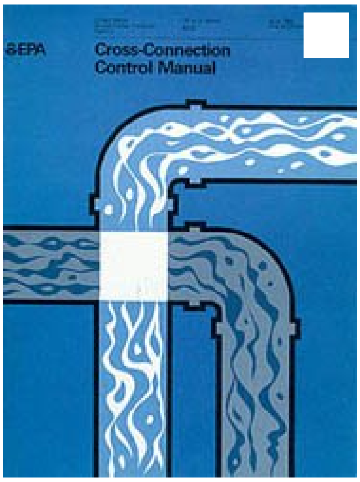
- Discussion about Potential Distribution System Problems <https://epa.gov/dwsixyearreview/discussion-about-potential-distribution-system-problems>
- Distribution System White Papers <https://epa.gov/dwsixyearreview/distribution-system-white-papers>

Protecting water quality in distribution systems

The following EPA drinking water regulations pertain to distribution systems:

- Surface Water Treatment Rules (disinfectant residual and sanitary survey requirements)
- Stage 1 and 2 Disinfectants and Disinfection Byproducts Rules (DBPR) (monitoring for DBPs in the distribution system)
- Ground Water Rule (sanitary surveys)
- Revised Total Coliform Rule (monitoring for bacterial contamination in distribution systems)

Cross Connection Control Manual



This *Cross-Connection Control Manual* has been designed as a tool for:

- Health officials
- Waterworks personnel
- Plumbers
- Any others involved directly or indirectly in water supply and distribution systems

It is intended to be used for educational, administrative, and technical reference in conducting cross-connection control programs.

- Read the Cross-Connection Control Manual

Contact Us <https://epa.gov/dwsixyearreview/forms/contact-us-about-six-year-review-drinking-water-standards> to ask a question, provide feedback, or report a problem.

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Plumbing Boilers

There are different methods to piping boilers, and outcomes, too.

December 7, 2017
Harvey Ramer
No Comments

Plumbing boilers; now this is a topic of great contention! It is also one where nearly every heating person considers their way to be the absolute best way, and don't you dare try to tell them anything different. They can take it as a direct affront. In their mind, you are telling them they have been doing things wrong their whole life. They know this isn't true, because their customers had heat. And so, they will continue to do things as they have been and scoff at anyone who tries to tell them different.

I was invited to a party one night. This was when I was younger than I am now, which means I was barely out of my teens. Like most other young men of that age, I had some characteristics that frequently got me in trouble. You see, I had been studying hydronics for quite some time, and I had the presumptuous attitude that everyone else in the heating business was dying to know what I learned. And so, unabashed, I was talking about hydronics with almost everyone, whether they wanted to hear it or not. Most, I believe, didn't, but they were polite about it. Except for this one guy at the party.

This party took place at a cabin on the top of the Blue Mountain, which is part of the Appalachian mountain range. From up there we had a spectacular, bird's eye view of the Cumberland valley. There were lots of great people there, and of course, I found the only other heating guy there and promptly engaged him in a conversation about boilers.

I asked him, "So how are you piping your boilers?"

He took another swallow of beer, wiped his chin, took on an air of someone in the know and proceeded to give me some details on his method of installation.

I listened carefully, and when he was done talking, I began telling him about the things I had learned and what was the correct way to pipe boilers. As I was talking, I noticed his face getting darker and taking on a surly constitution. Undaunted, I continued until he suddenly interrupted me.

"Are you trying to tell me you know more about boilers than the old plumber that I work for?" he asked. "He's been doing this his whole life and knows darn near everything there is to know about boilers! He has taught me everything. Are you trying to tell me he is wrong?"

"Well, no," I said. "It's just that…"

Not letting me finish my sentence, he leaned in so close I could smell the alcohol on his breath, and in a menacing tone said, "Yes you are. That's exactly what you are saying!"

I took a step back and fumbled for words. He looked like he was ready to take a swing at me.

After a brief but awkward moment of silence, he sneered and said, "Oil heat is the best heat." After delivering that powerful punch line, he took another swallow of beer, wiped the dribbles off his chin and strutted away.

This experience was quite a letdown for me, but it taught me a lesson. Not everyone wants to hear about hydronics, particularly at a party. And when trying to share knowledge about piping boilers, a great deal of finesse is required for most people. And most importantly, don't try to teach someone who doesn't want to be taught.

Throughout the years, I have also learned there is no "one way" of piping boilers that is always the right way. How one should pipe a boiler has a lot to do with what kind of emitter system they are connected to. So, here is one method that has given me marvelous results.

Cast iron boilers with old radiators

There are still many of these old cast iron radiator systems out there today. Some have been in place for close to a 100 years and are still keeping occupants toasty warm, but it seems the radiators last longer than the boilers, and so we frequently find ourselves doing a boiler replacement in such a system. Some people elect to go with a new high-efficiency condensing boiler, however, the majority of replacements are still cast iron boilers.

One of the first things that comes to mind when installing a cast iron boiler in a radiator system is "boiler protection."

What is boiler protection you ask?

Well, it works this way: a cast iron radiator system usually holds a lot of water, and just look at all the big old steel pipes. All that water, steel and cast iron equates to a lot of mass! All that mass must be heated up before the radiators begin to produce heat.

So, when the thermostat first turns on the boiler and pump, cold water will enter the boiler return for quite some time before the system heats up. This makes the boiler block cold and causes the flue gasses to condense both inside the boiler and in the chimney. This is not a good thing because these boilers and their chimney vents are not designed to handle the condensate. The condensate is acidic, with a PH of 3-4, and will cause the cast iron boiler block to rust away. It will also destroy the boiler vent and eventually the chimney flue.

How do we keep that from happening?

I'm glad you asked.

There are several different ways to solve that problem, and they are not all equal in the level of effectiveness and resulting boiler efficiency.

For this discussion, let's assume you did a heat load on the building and sized the boiler according to the actual load, rather than sizing it to the radiation or merely replacing it with the same size as was there before. This is, after all, proven to be the best way.

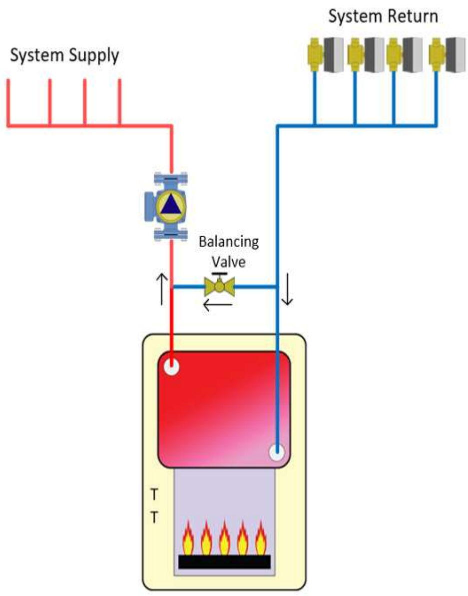
The first method, and the least effective for this type of system, is as follows.

The boiler aquastat will typically have a ZC-ZR terminal along with a C1 and C2 terminal. These terminals can be used to control the system pump or pumps. When wired properly, the terminals will not energize the pumps until the boiler heats up and reaches the low limit setting on the aquastat. Once it does, the pump will turn on, send all the heated water out into the system and replace it with cold water coming back from the system. The boiler quickly drops in temp, and the pump is turned back off. Meanwhile the boiler, full of heated water that was sent out into the system, starts doing what hot water does when it is mixed with colder water; it tries to find the highest spot in the system.

If you have a two-story house, you will typically find this heated water going to the upstairs first. This is because hot water is lighter than denser, cold water, and gravity forces it to do that. This process repeats itself until the whole system is heated up and the thermostat is satisfied. It's not a very efficient way to run a boiler.

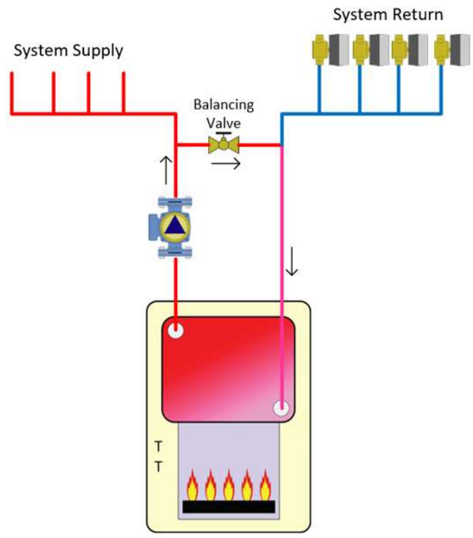
The second method takes a step in the right direction. It incorporates all the procedures described in the first method, but adds one more function — a bypass loop with a manual balance valve. What this bypass does is allow some of the return water to bypass the boiler and go directly into the boiler supply pipe. That slows down the flow through the boiler and allows the pumps to stay on rather than turn on and off as described in the first method.

The bypass pipe must be the same size as the boiler supply and return pipe. To set the flow in the bypass, one should start with the valve fully open. Then all zones should be turned on. Once the boiler reaches the low limit and turns on the pumps, begin slowly closing the bypass, while keeping an eye on the boiler temperature. The valve should be closed as far as possible while still allowing the boiler to remain above the low limit, and by extension, the pumps to stay energized. This will result in less boiler cycling and allow the emitter system to heat up more evenly.



This does not, however, add complete boiler protection. The return water temp will still be the same temp as what is returning from the system. It will merely be at a reduced flow rate, which can put an unwary heating contractor in a predicament. The reduced flow rate through the boiler will also reduce the boiler's total BTU/hr output once the system is heated up. Likewise, the radiation will have a reduced output as well due to the lower water temp caused by mixing the return water into the boiler supply. This is usually not a problem on these systems, as many of them have oversized radiation as compared to the actual building heat loss. When this is the case, the radiators can adequately heat the space with a lower water temp. If the radiation is properly sized though and requires the higher water temp, the system may not deliver the required heat on the coldest days of the year.

The third method uses the same principals as the second method, but the bypass is positioned differently. This method provides better protection to the boiler, as it mixes hot water from the boiler supply with the return water coming back from the system, thus raising the actual return water temp going into the boiler.



But let's take a look at what is happening in the system. First of all, we have slowed down the flow rate going to the system due to the bypass. This means reduced heat output to the system, but, more importantly, we have created a large Delta-T between the supply and return water temps. This does not usually work well with these radiator systems. The slow moving hot water quickly finds its way to the highest radiators and turns them into robust heat emitters while the lowest radiators sit patiently waiting on their turn for heat. And it will come, but not before the tenants on the second floor start hatching a plan to come downstairs and rip the thermostat off the wall.

In a nutshell, this results in uneven heating.

Moving on.

Let's take a new approach and look at primary secondary piping as our fourth method. With this method we decouple the boiler loop from the system loop and add a pump for each. This provides full flow through both the boiler and the system and allows for a mixing point at the closely spaced tees that connect the boiler loop to the system loop.

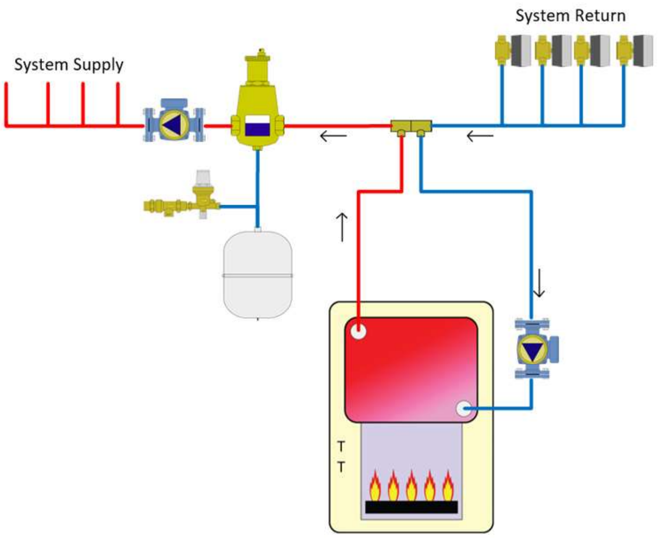
This is a great approach for a zoned system most of the time. It allows individual zones to turn on and off without affecting the flow rate through the boiler. For example, let's say one zone turns on. At this point the system flow rate should be lower than the boiler flow rate. When this happens, the boiler supply water will enter the supply tee and split directions.

Some heated water will go out to the system (equal to the system flow rate), and some will take the opposite direction toward the return tee. At this point, it will mix with the return water from that zone and raise the temperature of the water returning to the boiler. As you can see, this is doing great! Providing boiler protection and maintaining full boiler output.

But what happens when all zones call for heat at the same time?

Let's look into that. If everything is properly sized and balanced, the total system flow rate should equal the flow rate in the boiler loop. At this point, all the boiler supply water is entering the supply tee and heading out to the system. Likewise, all the system return water is headed back to the boiler return. In this scenario, we have no boiler protection whatsoever. It is as if the closely spaced tees were not even there and the boiler was direct piped.

You might say, "Well that will never happen. All the zones never send a call for heat at the same time."

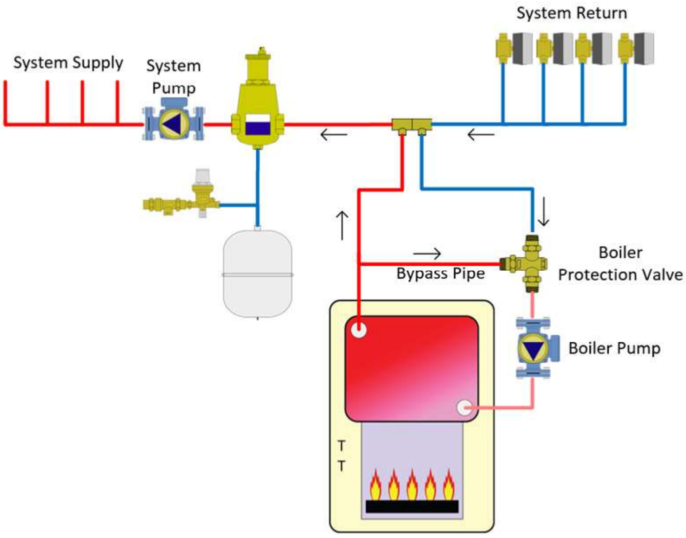


I might agree with you if today's trends coincided with the lifestyles of yesteryear. Lately, it seems everyone is insistent on having programmable thermostats installed. And you know what they do with them don't you? I do too. So, twice a day, all the zones send a call for heat at exactly the same time.

So what do we do, you ask? How can we make things better? How can we provide even heat to the radiators, decouple the system flow rates from the boiler flow rates, allow full boiler and system BTU outputs and provide boiler return protection all at the same time?

The answer, as is usually the case, comes from an unexpected place. And it is created by something you wouldn't expect — high energy costs. In recent years, we have seen the price of oil and LP gas go through the roof on several occasions. This has spawned an acute interest in renewable energies. One of these systems that runs on renewable energies are Biomass Systems. These systems typically lack fine control of the boiler's heat output, and therefore need a large storage tank to store the heated water until the system needs it. Heating such a large volume of water with a non-condensing boiler spawned the invention of a mixing device designed to raise the boiler's return water with the boilers supply water.

In this, the fifth and my preferred method, we have both a bypass installed and primary secondary piping via closely spaced tees. In this application, you will notice there is no manual balance valve installed on the bypass. The bypass is controlled by boiler protection valve (thermostatic mixing valve). This valve is controlled by a thermostatic element designed to maintain an outlet temperature not lower than the specified value. It does this by controlling the flow of the bypass and the flow from the return tee of the closely spaced tees. It is able to completely close off either inlet port.



So let's start up a cold system. The boiler pump and burner turn on; the system return port to the boiler protection valve (BPV) is fully closed; and the bypass is fully open. All the flow from the boiler is just making a loop through the bypass and right back into the boiler. Meanwhile the system pump is running and all the water is zipping right through the closely spaced tees with no heat being added. As the boiler heats up and the return water temp reaches 130 F, the BPV begins to slowly close the bypass and open the system return port, while keeping the boiler return at 130 F. As this happens, some hot boiler supply water begins entering the supply tee, where it is mixed with the system water. This slowly adds heat to the system water and brings the temperature of all the radiators up evenly and consistently.

This process continues until the system return temperature equals 130 F, at which point the bypass will be shut off completely, or until the call for heat is gone.

This method of piping provides quite a few benefits. The boiler can be set up to operate as a cold start, meaning the low limit can be disabled. On a call for heat, the boiler reaches its peak efficiency operating point within minutes. This point is when the block is as cold as possible without causing flue gas condensation.

On a single zone system, it will run at this operating condition for most of the heating season. Only once the outdoor temperature gets cold enough to require a higher water temperature, will the boiler start running at increased water temps and slightly lower efficiency. On a single zone system, this method outperforms one that operates the boiler on an outdoor reset curve. The boiler turns on when there is a heat demand and doesn't turn back off until the demand is met.

It also provides a very even and consistent heat across all the radiators.

This equals happy customers!

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Distribution

Distribution Systems & Their Maintenance

Introduction

Even if the water source for your small water system is of pristine quality, if the distribution system is not maintained or is in a state of disrepair, the quality of water may deteriorate before it reaches the customer.

The focus on this section is on the safe delivery of water. We will discuss the following:

- delivery of water
- some common issues and hazards that must be avoided
- sampling and monitoring
- operations and maintenance
- easements
- leak detection and water loss
- water metering
- the importance of a cross connection control program

Glossary of Terms
average daily consumption, bacteriological, coliform, contamination, disinfection, distribution system, Escherichia coli, gate valve, isolation valves, PSI, potable water, pressure, reservoir, residual chlorine, sediment, turnover rate, valves, watermains,

Delivery of Water

The primary function of any water distribution system is the transportation of drinking water safely to the consumer. The water source may originate from a well, river, lake or spring. In order to ensure the water is safe to drink (potable), it is usually treated to remove bacteria, viruses or parasites, and dissolved minerals that may cause illness in humans.

As the water flows through the distribution system, there are a number of components that keep the system operational. These include reservoirs, pumping stations, fire hydrants, air valves, gate valves and piping networks, each of which is described below.

The **reservoir** stores water for higher demand flows, such as for fire emergencies, and peak domestic flows, such as when people are getting ready for work in the morning and returning home later in the day. The reservoir also acts as a buffer in maintaining constant flow and pressure of water in the distribution system. For small water systems, pneumatic tanks are typically used instead of large reservoirs, as they, too, are capable of supplying and keeping up with the water demand. The tanks are generally not sized to provide fire flow. The minimum storage should be equal to the average daily consumption or the storage calculated to meet CT disinfection requirements, whichever is greater. A pressure switch regulates the amount of water to be stored in order to maintain a constant pressure in the distribution system.

Pumping stations are added to the distribution system to maintain pressure and delivery of water to uphill areas and reservoirs.

Air valves are devices that allow air to be introduced into the distribution pipe when a vacuum may be created. A vacuum can potentially damage the pipe or stop the water and is to be avoided. The air valves are located at high points in the distribution system.

Gate valves are added throughout the distribution system, so sections can be isolated for water main work and the water flow can be throttled for pipeline repair. They are a type of valve that uses a flow control element shaped like a sliding gate to block flow, often used as isolation valves.

Pipe networks' efficiency is effected by both the materials used and the layout. Pipe material is crucial for the efficient delivering of water. The smoother the interior of the pipe, such as with PVC pipes and ductile iron, the less friction there is. Also, the less twists and turns in the pipe, the more efficient the delivery of water.

Common Issues & Hazards

The greatest concerns for the safe delivery of water are **loss of pressure**, **loss of chlorine residual** and **cross contamination**.

Loss of pressure may result from a water main break, fire flow or inoperable pumping stations, due to power failure.

Loss of chlorine residual can be caused by a number of factors:

1. Source water quality: Water that is high in organic or inorganic matter will use up the chlorine residual faster than water that is lower in organic matter.
2. Residency time: The more time the water spends in storage and distribution, the more chlorine residual is used up. Long residency time can result from low water usage, dead ends in the distribution system and poor turnover in the reservoir.
3. Reaction with pipe materials: Some pipe materials (e.g., iron) can react with chlorine, resulting in loss of the residual.
4. Biofilm growth: Biofilm is a large colony of microorganisms that grown on pipe walls within the distribution system that will use up the chlorine residual.

If low chlorine residual is detected, you should flush the system until the residual is re-established. If chlorine levels continue to drop below an acceptable level, the cause should be investigated. Operators may consider increasing the disinfectant dose if that is not effective.

Cross contamination from the exterior environment into the water main may occur if there is a leak or opening in the pipe. Standard practice is to maintain a minimum water pressure of 20 psi to prevent the potential of cross contamination.

Bacteriological contamination and microbiological growth is also a concern. It may be introduced through a cross connection (more on cross connections at the bottom of this section) or failure to adequately treat the water at source.

Sampling & Monitoring

In order to ensure drinking water is bacteriological free, routine sampling is required under the *BC Drinking Water Protection Regulation* Schedule B, with the number of samples required determined by population. For most small water systems, which serve a population under 5,000, the minimum number of samples to be taken per month is four (4).

In order to determine the best sampling locations, it is best to consult with your local Drinking Water Officer. Typically, these sites include sampling at source, mid-point in the distribution system and at the far end. Once set, these locations remain permanent, in order to compare the latest samples with past results.

Schedule A of the *Drinking Water Protection Regulation* establishes the bacteriological standard that must be maintained according to the standards in the table below:

Schedule A

Water Quality Standards for Potable Water

(sections 2 and 9)

Parameter:	**Standard:**
Fecal coliform bacteria	No detectable fecal coliform bacteria per 100 ml
Escherichia coli	No detectable *Escherichia coli* per 100 ml
Total coliform bacteria	
(a) 1 sample in a 30 day period	No detectable total coliform bacteria per 100 ml
(b) more than 1 sample in a 30 day	At least 90% of samples have no detectable total

period	coliform bacteria per 100 ml and no sample has more than 10 total coliform bacteria per 100 ml

For monitoring mineral content, chemical samples are obtained from the source water both prior to treatment and after treatment. The comparisons determine how much of the mineral is removed. This is important for monitoring health-related parameters, such as arsenic, nitrates, total organic carbon, pesticide residues, etc.

Operations & Maintenance

It is essential that all equipment for operating and maintaining the distribution system is exercised (i.e., tested or used) on a regular basis. This ensures the water flow is minimally disrupted in the event of an emergency or during regular repair work. For example, in the event of a water main leak, valves can be easily operated if they were previously located and exercised. If a valve is not exercised, it may seize up or become difficult to turn, making the repair work much more difficult. Other challenges that may occur if the equipment is not regularly maintained include the failure of a backup generator to start in the event of a power failure or of a hydrant to deliver adequate water flow in an emergency.

Timing of Maintenance

- **Hydrants and valves** should be evaluated and exercised at a minimum once per year. If a hydrant is used, it should be evaluated afterwards.
- **Backup generators** should be tested each month.
- **Pumps** should undergo maintenance as per the manufacturer's recommendation.
- **Dead end mains** should be flushed on a routine basis to maintain water quality.
- **Water reservoirs** should be evaluated annually and cleaned every 3 to 5 years, based on sediment collection on the bottom.

Easements

An Easement or Right of Way (ROW) is a strip of land on private property that acts as a corridor for water mains, sanitary sewers and/or storm mains. With an easement, a legal agreement exists between the landowner and the utility to provide 24/7 access for operating, maintaining or repairing any component that requires attention. The minimum widths of these ROWs are generally 3 metres. Typically, the width is determined by 2 X depth of pipe + width of trench excavated. For example, if the top of the pipe is 1 m from the ground surface and the trench width is 1 m, the result is 2 X 1m depth of pipe + 1 m excavation trench = 3 m ROW width.

Leak Detection & Water Loss

Most water systems experience approximately 10% leakages and/or unaccounted water use. This may be from water main leaks, unaccounted water use from a property (running toilet or hoses), or illegal use of a fire hydrant.

Leaks may have originated from weakened joints or fitting connections or from a damaged or corroded part of the pipe. If unresolved, leaks may undermine pavement or other structures, resulting in damage. Perhaps the greatest concern is that the leak will soak the ground surrounding the pipe and, in the event that pressure is lost in the pipe, the water, combined now with dirt and other contaminates, may backflow into the pipe.

If a water system is metered, leak detection is easier to detect. Operators should try to isolate parts of the distribution system and pressure test. Once an area for the water loss is determined, specially trained personal use leak detection equipment to pinpoint the area. They typically use sound-intensifying equipment in a systematic fashion to locate leaks. Preliminary methods of locating leaks include damp spots or water seepage in the vicinity of mains or services.

Reference: *Water Distribution System Operation & Maintenance*, 5th Edition, A Field Study Training Program, California State University, Sacramento California, 2005, p.211.

Water Metering

Water metering establishes a user pay system, which ensures equity and fairness for water consumers. If a water system is unmetered and users pay a flat rate, there may be inequity if a neighbour uses more water for their green house and swimming pool and another one uses only water within the home.

The cost/benefit for establishing a metering program may be more beneficial for a large municipal system versus a smaller system, due to the lower dollar cost averaging for installation and maintenance of the meters. For smaller systems, it may be more beneficial to maintain a flat rate system (unmetered) and ensure users use water responsibly.

Cross Connections

In order to ensure the safe delivery of water to users, any potential cross connections with contaminated sources need to be addressed. This includes simple threats, such as leaving the garden hose in a pool or hot tub or leaving it connected to a pesticide dispenser. Any loss of pressure (negative pressure) from water delivery may turn the hose into a vacuum and draw the contaminated water into the plumbing system. More complex threat include a direct connection of an irrigation system to a water supply without the barrier of a backflow preventer, or the direct connection of the water to a chemical supply. The **backflow preventer** contains a spring-loaded valve that closes if the water flows in reverse, hence isolating the contaminated source from the water supply. In order to protect drinking water from all potentially contaminated sources, a cross connection control program should be instituted. The acceptable backflow preventer devices (BPDs) should be testable and meet the relevant CSA standards (i.e., CSA B64) or equivalent. Operation and maintenance of the water pipeline should include regular testing and maintenance of testable BPDs.

RESOURCES

Drinking Water Protection Act: Drinking Water Protection Regulation, Province of BC, Reg. 200/2003, including amendments up to B.C. Reg. 122/2013.

Water Distribution System Operation & Maintenance, 7th Edition, A Field Study Training Program, California State University, Sacramento California, 2018.

Chlorine Residual Maintenance: Fact Sheet, Water Research Australia (2015).