An Introduction to Backflow Prevention

Gary Brodie, Director Emerging Markets, Watts Industries EMEA BV

A Backflow Prevention device is used to protect potable water supplies from contamination or pollution due to backflow.

In water supply systems, water is normally maintained at a significant pressure to enable water to flow from the tap, shower etc. When pressure fails or is reduced, as may happen if a water main bursts, pipes freeze or there is unexpectedly high demand on the water system, then such reduced pressure in the pipe may allow contaminated water from the ground, from storage or from other sources to be drawn up into the system.

Backflow Preventer definition
A device that allows water to go through it in one direction, but prevents it from going backwards in the opposite direction.

Points at which a potable water system connects with a non-potable water system, are called cross connections.

Backflow means the undesirable reversal of flow of a liquid, gas or solid into the potable water supply — a backflow preventer keeps this from happening.

Back-siphonage occurs when higher pressure fluids, gases, or suspended solids move to an area of lower pressure fluids. For example, using a straw to drink a beverage; the suction of drink will make the pressure of fluid inside the straw lower, thus, liquid will move from the cup to inside the straw and then up to your mouth. This is an example of an indirect cross-connection — undesirable material is being pulled into the system.

If instead, air is blown through the straw and bubbles begin to erupt at the submerged end, this is an example of back-pressure. If instead of air, nat-
ural gas had been forced into a potable water tank, it in turn could be carried to your kitchen faucet. This is an example of a **direct cross-connection** — undesirable material is being pulled into the system.

Back pressure can force an undesirable contaminant to enter potable water piping. Sources of back pressure may be pumps in the water distribution system, boilers, heat exchanging equipment, or power washing equipment. In these cases there may be an almost constant risk of overcoming the static water pressure in the piping. To reduce the risk of contamination, a backflow preventer can be fitted. A backflow preventer is also important when potentially toxic chemicals are used, for instance for commercial/industrial descaling (boilers) or when bleaches are used for residential power washing.

A backflow preventer is like a one-way gate for water. Most backflow preventers are used to keep unsafe water from reversing flow and entering the clean water supply. Backflow preventers can be as simple as a single check valve that closes when water flow reverses. Using a simple check valve as a backflow preventer might be considered the equivalent of a turnstile at a store entrance, it is not very reliable, even a small amount of effort will overcome it. A more elaborate backflow preventer can be a complicated device that consists of multiple check valves, water release valves, air vents, and/or systems to allow it to be tested to assure it is working properly. This kind of backflow preventer might be the equivalent of an airport security checkpoint with one-way gates and an armed guard.

**You should have a backflow preventer on your water system if your water comes from a “potable” (drinkable) source.** If your water source is considered potable, then in North America and in most European countries it is illegal to not have the proper local authority-approved type of backflow preventer on your system. If your water source is non-potable, you generally are not required by law to use a backflow preventer (but not always, some jurisdictions even require them for non-potable water like recycled, reclaimed, and gray water sources.)

There are many types of backflow preventers. Within the U.S.A., the local authorities will dictate that certain types of backflow preventers may NOT be used with systems within their jurisdiction. In some cases, the authorities will dictate the exact type of backflow preventer you MUST use. You may hear or see the term **“Cross-Connection Control”**, this essentially is referring to backflow prevention. A cross connection is a connection between a drinking water supply and a source of pollution or contamination.

**What’s potable water?**

Definition: potable water means the water is suitable for drinking. Depending on local law, that may include drinking water for animals. If you would be willing to drink it without treatment, then it is probably going to be considered potable. Non-potable water is water that is not suitable for drinking. Examples of water sources that are often considered non-potable are lake and pond water, water from streams, and well water from a contaminated aquifer that is not suitable for drinking. Most other wells do require a backflow preventer, even if the well doesn’t provide drinking water. This is to protect the aquifer the well takes the water from, because even if you don’t get drinking water from the well, your neighbors may get drink-
or pet!

Now wait a minute, some people say, doesn’t the water pressure in the water system keep the irrigation water from going backwards? Yes, most of the time it does. But there are times when the water pressure drops in the supply system, and this is when the backflow occurs. No, it is not a frequent occurrence. But it does happen more often than you think, often at night when you don’t notice the water was off for a few minutes. Such as when the water company has to shut off the water to repair a water pipe, or hook up a new pipe. This makes construction projects easily the most common cause of backflow problems. Fire fighting is another common cause of backflow. Fire trucks use huge pumps to suck the water out of the fire hydrants. This often causes the water pressure in the surrounding areas to drop, and backflow will occur in the surrounding neighborhoods.

You can do a quick experiment yourself and create backflow in your home pipes. Simply turn off the water valve leading to your house. Next have someone turn on a faucet. Now turn on a different faucet that is higher than the first. You will hear air being sucked into the higher faucet. You just created backflow in your house piping. Pretty easy, wasn’t it?

Another common argument against the need for backflow preventers is that if all the valves are closed the water can’t go backwards through them. So the valves should prevent backflow. The obvious problem with this is that if the backflow occurs at a time when the valve is open, like when the sprinklers are on, the valve will not stop backflow! But even when the valve is closed it may not prevent backflow. A standard manually operated valve should stop backflow when it is closed—if the valve if fully closed, has good seals, and does not leak. However most of the automatic valves, such as the electric solenoid valves used for irrigation systems, will not stop backflow even when “off” and fully closed. This is because these solenoid valves are directional in design. If you look on the valve you will see that it has an arrow on it showing the flow direc-
tion. If the flow is reversed, the valve will often open slightly (that’s why the valve has the arrow on it—to warn you not to install it backwards!) Thus when backflow occurs and the flow direction reverses, an automatic valve will not stop the backward flow.

**How to Select a Backflow Preventer**

There are several types of backflow preventers available, so let’s take a look at your options. Regulations vary depending on location. Backflow preventers are expensive, so you do not want to have to tear it out and install a different one!!!

The following questions will help you decide which type to use. Each type is described in detail further down in this article.

1. Is this a commercial or a single family residential site?
   - **Commercial:** (This includes any business property, including apartment complexes and condominiums.) Use a **Reduced Pressure Type Backflow Preventer.** This is the industry standard throughout Europe and North America. For commercial projects you don’t take chances, you use a Reduced Pressure Type because it provides the highest level of protection. If something goes wrong a commercial property owner is likely to be held to a very high standard. An hour of your attorney’s time in court costs you more than any backflow preventer!
   - **Single Family Residential:** Continue to the next question.

2. Do you plan to use fertigation, apply fertilizer, pesticides (such as for insect control), or apply anything other than pure water using your irrigation system? This includes products labeled as “organic”, “natural”, and “safe”. This also includes the “safe” mosquito control products applied by misters and sprinklers. Remember all these products are concentrated in the irrigation system water, so while they may be safe when dispersed into the air, they can be much more dangerous when concentrated in the water in the pipes.
   - **Yes:** Use a **Reduced Pressure Type Backflow Preventer.**
   - **No:** Continue to the next question.

3. Do you want the backflow preventer to be installed below ground in a valve box?
   - **Yes:** Consider a **Double Check Type Backflow Preventer.** This is the only type that can be installed in a box below ground. Note: other types may sometimes be installed in a large vault with unblockable drainage. (For example, you can generally put a Reduced Pressure Type Backflow Preventer in a large basement.)
   - **No:** Continue to the next question.

4. Is it possible to install the backflow preventer in a location where it will be at least 6 inches (150mm) above all of the sprinkler heads or drip emitters/drippers?
   - **Yes:** Continue to the next question.
   - **No:** Use either a **Reduced Pressure** type or **Double Check type.**

5. Is the area to be irrigated reasonably small, such as a front yard or back yard of a tract home?
   - **Yes:** Continue to the next question.
   - **No:** Use a **Pressure Vacuum Breaker, Reduced Pressure Zone or Double Check type.**

6. Would it be acceptable to you if one or more valves are installed on pipes, at least 6” above ground? (Maybe you can hide them behind a shrub or put a decorative cover over them.)
   - **Yes:** Use **Anti-Siphon Valves.**
   - **No:** Use a **Pressure Vacuum Breaker, Reduced Pressure Zone or Double Check type.**

**Types of Backflow Preventers**

Following is a list of the various types of backflow preventers. All of the following backflow preventer types are available in all sizes. You may need to contact a specialty store or plumbing supplier to obtain some of these backflow preventers.

**Atmospheric Vacuum Breaker:** The atmospheric vacuum breaker (AVB)
is the least expensive backflow preventer. It may not be installed in any location where it might ever be submerged under water, like in a underground box. As a general rule AVBs are not economically practical if you have more than 6 or so valves. In this case you would want to consider a pressure vacuum breaker. Some municipalities do not allow the use of AVBs. Most people use a anti-siphon valve rather than a valve and a separate AVB. An anti-siphon valve is generally less expensive and less work to install. If you install any valves, of any type, on the pipes downstream of the AVB, the AVB will not work! The downstream valve creates “back pressure” on the AVB which causes the vent in it to jam in the closed position. If this vent can’t open, the AVB will not prevent backflow.

Anti-Siphon Valve: An anti-siphon valve is a manual or automatic control valve with a built-in atmospheric vacuum breaker. If you install any valves, of any type, on the pipes downstream of the anti-siphon valve, the anti-siphon valve will not work! The downstream valve creates “back pressure” on the anti-siphon valve which causes the vent in it to jam in the closed position. If this vent can’t open, the anti-siphon valve will not prevent backflow. It may not be installed in any location where it might ever be submerged under water. Anti-siphon valves are the most common type of backflow preventer used on residential systems, primarily because they are simple and inexpensive. Some municipalities do not allow the use of anti-siphon valves, so it is best to check with the water company first. Generally you would install the anti-siphon valves in one or more groups, at the highest point in the system. A mainline pipe is run to the anti-siphon valve location(s) from the water source. Pipes then extend from each anti-siphon valve to the sprinklers or emitter pipes. Water may come out of the anti-siphon valve periodically, so make sure you install them someplace where a little spilled water will not be a problem. The water will come out of the vent, which is under a cover on the top of the downstream side of the valve (you can see the vent holes under the cover if you turn the valve upside down and look for them).

If water does come out of the anti-siphon it means something is wrong that needs to be fixed. In most cases it means either a stick or rock got into the anti-siphon seal and jammed it open, or the anti-siphon valve was not installed higher than all the sprinkler heads or emitters.

1. Never install an anti-siphon valve upstream of any other valve. If you do the anti-siphon valve will not prevent backflow and you have wasted your money buying it.

2. Never use an anti-siphon valve as a backflow preventer installed on the mainline upstream of other valves. This is a common error that a lot of people make. I have heard employees at home improvement stores recommend installing a anti-siphon valve as a backflow preventer with standard electric globe valves installed after it for each of the sprinkler zones. I have seen many contractors do this also. Both should know better! Don’t you do it!!! It will damage the anti-siphon valve. Plus the anti-siphon valve will not prevent backflow when installed this way. You are no better off than if you didn’t use a backflow preventer at all. (Contractors and suppliers: before you flame me for being wrong, do some research. Don’t embarrass yourself! Most anti-siphon valves have a warning on the box or in the installation instructions about this. Just read the instructions!)

3. If you plan to use anti-siphon valves, every one of your sprinkler or drip zone control valves must also be an anti-siphon valve. You can use a ball valve upstream of the anti-siphon valves for an emergency shutoff. But no valves may be downstream of them. If you are paying attention you will note that essentially this is the same thing I said in #1 and #2 above!

So hopefully you’re getting the message by now!

4. Anti-siphon valves should never be installed below ground.

5. You can build an enclosure around the anti-siphon valves to hide them. But they must be above ground, and
the enclosure must allow water to freely drain out of it if the anti-siphon valves leak.

**Pressure Vacuum Breaker:** A pressure vacuum breaker (PVB) is similar to an atmospheric vacuum breaker except that you only need to install one of them and it is installed on the mainline. Like the AVB it must also be installed above ground. In a sloped yard, it would typically need to be installed at the highest point in the yard, with a mainline pipe running up to it from the water source, and then another mainline running back down to the control valves.

A few local authorities require that the PVB be installed within 18 inches (450mm) of the connection to the water source, in which case you can't use a PVB unless the water source is at the high end of the area. It may not be installed in any location where it might ever be submerged under water. Some municipalities do not allow the use of a PVB at all, so check with your water provider. A PVB backflow preventer may spit or spill water out from under the cap when backflow occurs, so it should be installed in a location where water spillage would not cause problems.

**Warning:** If used on a water system where a pump and pressure tank supplies the water (like is used on most rural homes that have a well), the PVB may spit water each time the pump shuts off. This is because the pressure variations caused by the pump and pressure tank system can cause backflow from the irrigation system back into the water system. The likelihood of water spitting, and the amount of water that spits out, both increase with a longer mainline on the system. So if you have 10 feet (3m) of mainline between the PVB and the farthest valve there is less likely to be water spitting than if you have 500 feet (150m) of mainline pipe. One way to stop, or at least reduce, this water spillage is to install a spring-loaded check valve right after the PVB. The PVB may still spill a little water with the check valve installed, however, in most cases it should be much less water.

**Reduced Pressure Zone Backflow Preventer:** The reduced pressure zone backflow preventer (R.P. Unit) is the king of the backflow preventers, made for high-hazard uses. It is also an expensive piece of equipment. It is the standard for ALL European installations. This is the type of backflow preventer that is used more than all others combined. The R.P. Unit must be installed 12 inches (300mm) above ground. It may not be installed in any location where it might ever be submerged under water. If installed in a structure or basement there must be a drain located near the backflow preventer. A single R.P. Unit is installed upstream of all the valves. Drive through any commercial business area in Europe or North America and you will likely spot a lot of these units, most often sitting right out by the street. Many times you may see several grouped together, each used for a different purpose. R.P. Units may spit out water if they detect backflow, they also spit water if they are broken. So don’t install them inside a building without providing a floor drain.

**Double Check Backflow Preventers:** Depending on who you ask, double check backflow preventers may or may not be appropriate for some systems. In many communities they are legal to use, and even recommended by local officials. Other communities do not allow them to be used on irrigation systems. I will attempt to present both sides of the argument.

Don’t be fooled! A “Dual Check” is NOT the same thing as a “Double Check Backflow Preventer”! They sound very similar, and they are “relatives”, but they are not the same. Dual check backflow preventers are for use with non-toxic materials. A typical use for a dual check is to install it where your house water supply connects to the water district’s pipe. The water in your house is (hopefully!) non-toxic, so a dual check is OK. The water in your irrigation system is not as likely to be non-toxic, so a dual check is NOT OK! So how do you recognize which is which when you see them? A Double Check will ALWAYS have two manual valves, one on the inlet and one on the outlet. These manual valves are used as emergency shut-offs and are
also necessary to properly test the operation of the backflow preventer. A Double Check will also have test cocks (small outlets sticking out of the side of the backflow preventer) for connecting to test gauges. If it doesn't have those shut off valves and test cocks it is NOT a Double Check Backflow Preventer! Many communities that allow double check backflow preventers do not allow the use of dual check backflow preventers. Don't mistakenly buy the wrong thing!

First let’s take a look at what a double check is and how it works. A double check backflow preventer is simply two spring-loaded check valves in a row, with a shut-off valve on either end and test cocks to allow the unit to be tested for proper operation. The double check backflow preventer is the only true backflow preventer which does not have a vent to allow air to enter the lines or to allow water to escape when backflow occurs. It relies entirely on the tight seal of the two check valves to prevent backflow. In most places where double check backflow preventers are legal, local officials will allow them to be installed underground in a vault. But not all do, so you should always check with local officials before installing the unit underground. Double check backflow preventers can be installed lower than the water system and often they are installed in basements in order to protect them from freezing. Regardless of where they are installed they must be readily accessible for maintenance and testing. Even in areas where double check backflow preventers are approved for use they may not be used on any irrigation system where chemicals (fertilizers, pesticides, fungicides, pipe cleaning agents) are injected into the irrigation water.

In summary, protection of Potable Water systems should be one of our highest priorities in the modern world. So often, doing this is totally overlooked and doing so can have catastrophic results. Cross Connections are everywhere, and the potential for them to contaminate water should never be underestimated. It is up to responsible designers and engineers to recognize this problem, and they must assume the responsibility of protecting others from the possible harmful effects of contaminated water. This is clearly legislated for in many countries but not in all – but we do not have to wait for legislation to ensure we are acting responsibly. If you have any doubts or questions please contact a recognized Backflow Preventer manufacturer or the author.