Public *Accommodation* Facilities *Regulations*

Effective April 2006

Appendix A:
Public Health Significance of Cross-Connections

Serving Boulder City, Clark County, Henderson, Las Vegas, Mesquite and North Las Vegas

Southern Nevada Health District

Southern Nevada District Board of Health
P.O. Box 3902, Las Vegas, NV 89127 | 702.759.1000

Chapter Two

Public Health Significance of Cross-Connections

Public health officials have long been aware of the impact that cross-connections play as a threat to the public health. Because plumbing defects are so frequent and the opportunity for contaminants to invade the public drinking water through cross-connections are so general, enteric illnesses caused by drinking water may occur at most any location and at any time.

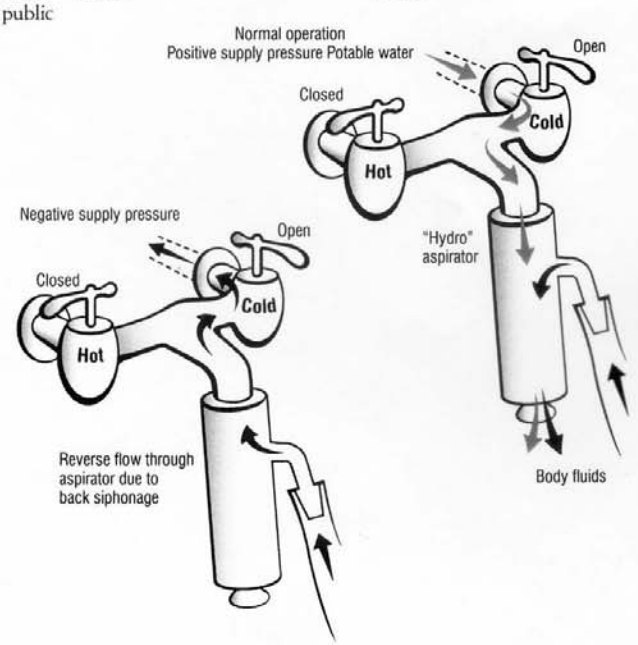
The following documented cases of cross-connection problems illustrate and emphasize how actual cross-connections have compromised the water quality and the public health.

Human Blood in the Water System

Health Department officials cut off the water supply to a funeral home located in a large southern city, after it was determined that human blood had contaminated the fresh water supply. City water and plumbing officials said that they did not think that the blood contamination had spread beyond the building, however, inspectors were sent into the neighborhood to check for possible contamination. The chief plumbing inspector had received a telephone call advising that blood was coming from drinking fountains within the building. Plumbing and county health department inspectors went to the scene and found evidence that the blood had been circulating in the water system within the building. They immediately ordered the building cut off from the water system at the meter.

Investigation revealed that the funeral home had been using a hydraulic aspirator to drain fluids from the bodies of human "remains" as part of the embalming process. The aspirator directly connected to the water supply system at a faucet outlet located on a sink in the "preparation" (embalming) room. Water flow through the aspirator created suction that was utilized to draw body fluids through a hose and needle attached to the suction side of the aspirator.

The contamination of the funeral home potable water supply was caused by a combination of low water pressure in conjunction with the simultaneous use of the aspirator. Instead of the body fluids flowing into the sanitary drain, they were drawn in the opposite direction—into the potable water supply of the funeral home!



Source Document: United States Environmental Protection Agency's Cross-Connection Control Manual, February 2003 available at http://www.epa.gov/safewater/crossconnection.html

Burned in the Shower

A resident of a small town in Alabama, jumped in the shower at 5 a.m. one morning in October, 1986, and when he got out his body was covered with tiny blisters. "The more I rubbed it, the worse it got," the 60 year old resident said. "It looked like someone took a blow torch and singed me."

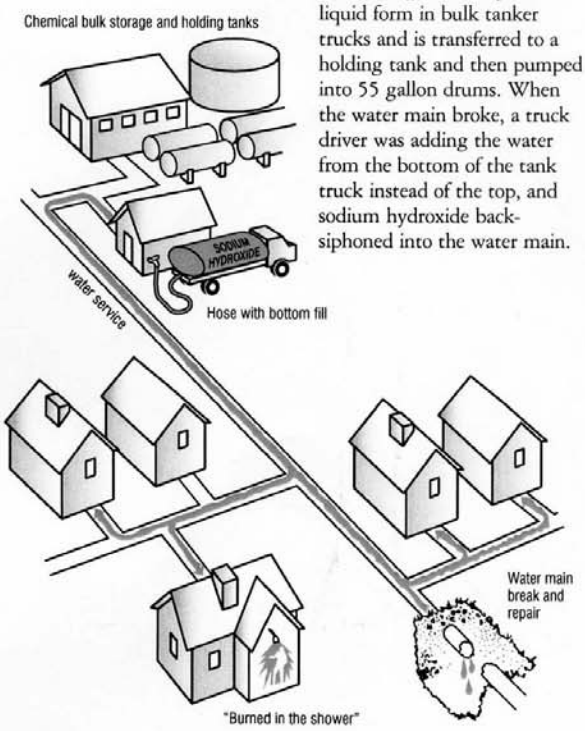
He and several other residents received medical treatment at the emergency room of the local hospital after the water system was contaminated with sodium hydroxide, a strong caustic solution.

Other residents claimed that, "It (the water) bubbled up and looked like Alka Seltzer. I stuck my hand under the faucet and some blisters came up."

One neighbor's head was covered with blisters after she washed her hair and others complained of burned throats or mouths after drinking the water.

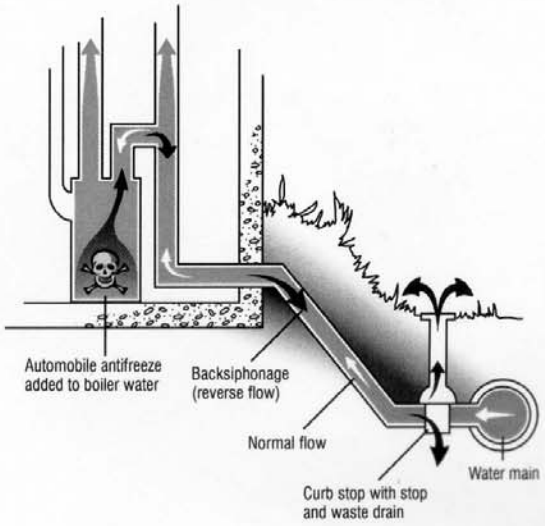
The incident began after an 8-inch water main, that fed the town, broke and was repaired. While repairing the water main, one workman suffered leg burns from a chemical in the water and required medical treatment. Measurements of the ph of the water were as high as 13 in some sections of the pipe.

Investigation into the cause of the problem led to a possible source of the contamination from a nearby chemical company that distributes chemicals such as sodium hydroxide. The sodium hydroxide is brought to the plant in liquid form in bulk tanker trucks and is transferred to a holding tank and then pumped into 55 gallon drums. When the water main broke, a truck driver was adding the water from the bottom of the tank truck instead of the top, and sodium hydroxide back-siphoned into the water main.



Heating System Anti-Freeze into Potable Water

Bangor Maine Water Department employees discovered poisonous antifreeze in a homeowner's heating system and water supply in November, 1981. The incident occurred when they shut off the service line to the home to make repairs. With the flow of water to the house cut off, pressure in the lines in the house dropped and the anti-freeze, placed in the heating system to prevent freeze-up of an unused hot water heating system, drained out of the heating system into house water lines, and flowed out to the street. If it had not been noticed, it would have entered the homeowner's drinking water when the water pressure was restored.



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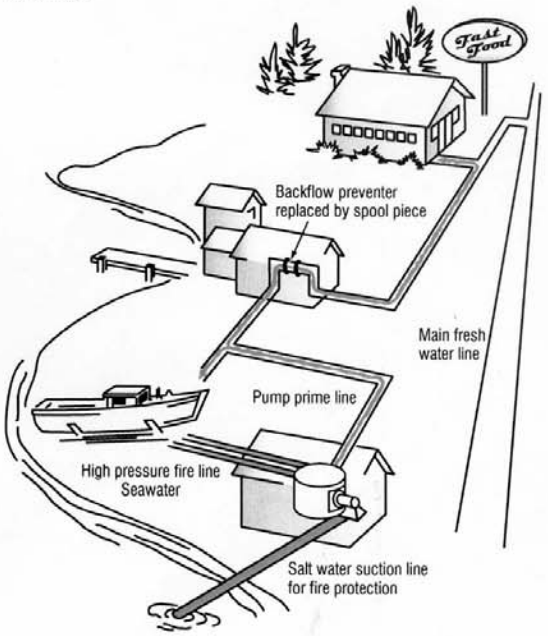
Salty Drinks

In January, 1981, a nationally known fast food restaurant located in southeastern United States, complained to the water department that all their soft drinks were being rejected by their customers as tasting "salty." This included soda fountain beverages, coffee, orange juice, etc. An investigation revealed that an adjacent water customer complained of salty water occurring simultaneously with the restaurant incident. This second complaint came from a water front ship repair facility that was also being served by the same water main lateral. The (investigation centered on the ship repair facility and revealed the following:

- A backflow preventer that had been installed on the service line to the shipyard had frozen and had been replaced with a spool piece sleeve.
- The shipyard fire protection system utilized sea water that was pumped by both electric and diesel driven pumps.
- The pumps were primed by potable city water.

With the potable priming line left open and the pumps maintaining pressure in the fire lines, raw salt water was pumped through the priming lines, through the spool sleeve piece, to the ship repair facility and the restaurant.



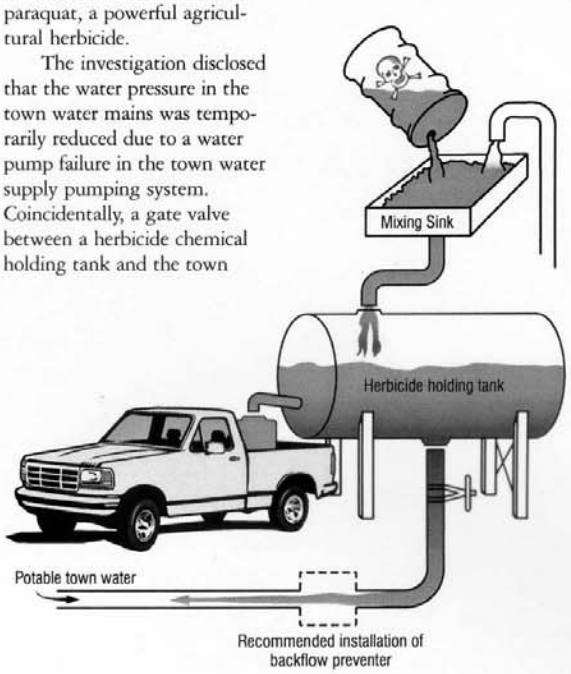
Paraquat in the Water System

"Yellow gushy stuff" poured from some of the faucets in a small town in Maryland, and the State of Maryland placed a ban on drinking the water supply. Residents were warned not to use the water for cooking, bathing, drinking or any other purpose except for flushing toilets.

The incident drew widespread attention and made the local newspapers. In addition to being the lead story on the ABC news affiliate in Washington, D.C. and virtually all the Washington/Baltimore newspapers that evening. The news media contended that lethal pesticides may have contaminated the water supply and among the contaminants was paraquat, a powerful agricultural herbicide.

The investigation disclosed that the water pressure in the town water mains was temporarily reduced due to a water pump failure in the town water supply pumping system. Coincidentally, a gate valve between a herbicide chemical holding tank and the town water supply piping had been left open. A lethal cross-connection had been created that permitted the herbicide to flow into the potable water supply system. Upon restoration of water pressure, the herbicides flowed into the many faucets and outlets on the town water distribution system.

This cross-connection created a needless and costly event that fortunately did not result in serious illness or loss of life. Door-to-door public notification, extensive flushing, water sample analysis, emergency arrangements to provide temporary potable water from tanker trucks, all contributed to an expensive and unnecessary town burden.



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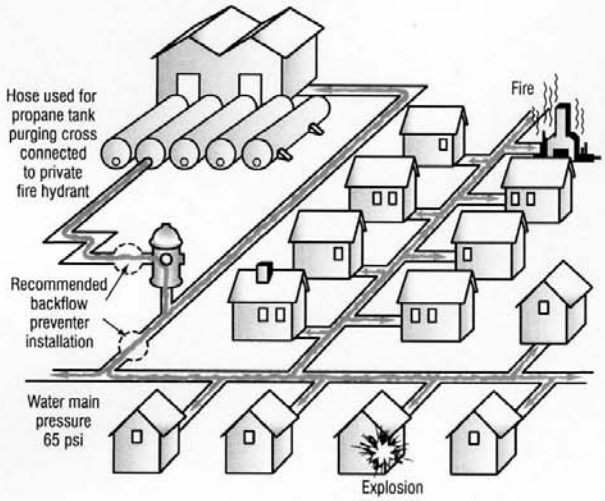
Propane Gas in the Water Mains



Hundreds of people were evacuated from their homes and businesses on an August afternoon in a town in Connecticut in 1982 as a result of propane entering the city water supply system. Fires were reported in two homes and the town water supply was contaminated. One five-room residence was gutted by a blaze resulting from propane gas "bubbling and hissing" from a bathroom toilet and in another home a washing machine explosion blew a woman against a wall. Residents throughout the area reported hissing, bubbling noises, coming from washing machines, sinks and toilets. Faucets sputtered out small streams of water mixed with gas and residents in the area were asked to evacuate their homes.

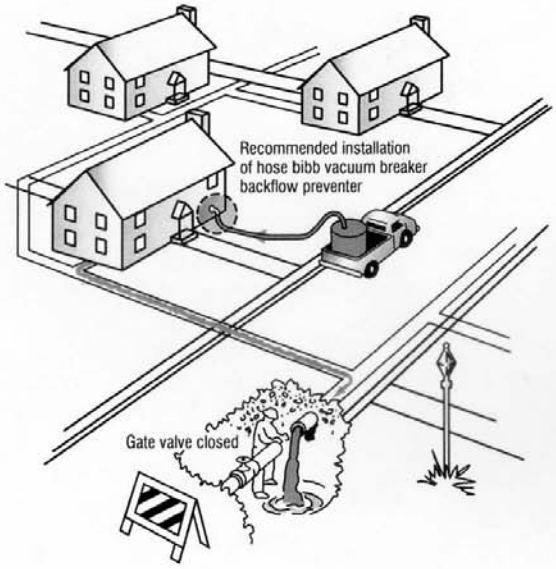
This near-disaster occurred in one, 30,000 gallon capacity liquid propane tank when the gas company initiated immediate repair procedures. To start the repair, the tank was "purged" of residual propane by using water from one of two private fire hydrants located on the property. Water purging is the preferred method of purging over the use of carbon dioxide since it is more positive and will float out any sludge as well as any gas vapors. The "purging" consisted of hooking up a hose to one of the private fire hydrants located on the property and initiating flushing procedures.

Since the vapor pressure of the propane residual in the tank was 85 to 90 psi., and the water pressure was only 65 to 70 psi., propane gas backpressure backflowed into the water main. It was estimated that the gas flowed into the water mains for about 20 minutes and that about 2,000 cubic feet of gas was involved. This was approximately enough gas to fill one mile of an 8-inch water main.

Chlordane and Heptachlor at the Housing Authority

The services to seventy five apartments housing approximately three hundred people were contaminated with chlordane and heptachlor in a city in Pennsylvania, in December, 1980. The insecticides entered the water supply system while an exterminating company was applying them as a preventative measure against termites. While the pesticide contractor was mixing the chemicals in a tank truck with water from a garden hose coming from one of the apartments, a workman was cutting into a 6-inch main line to install a gate valve. The end of the garden hose was submerged in the tank containing the pesticides, and at the same time, the water to the area was shut off and the lines being drained prior to the installation of the gate valve. When the workman cut the 6-inch line, water started to drain out of the cut, thereby setting up a backsiphonage condition. As a result, the chemicals were siphoned out of the truck, through the garden hose, and into the system, contaminating the seventy five apartments.

Repeated efforts to clean and flush the lines were not satisfactory and it was finally decided to replace the water line and all the plumbing that was affected. There were no reports of illness, but residents of the housing authority were told not to use any tap water for any purpose and they were given water that was trucked into the area by volunteer fire department personnel. They were without their normal water supply for 27 days.



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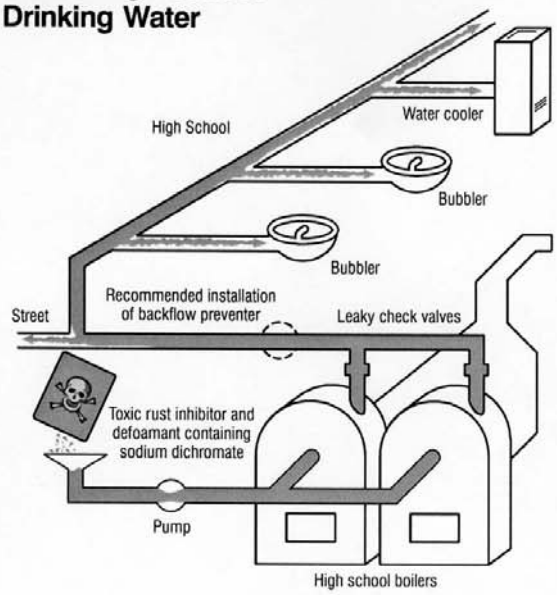
Boiler Water Enters High School Drinking Water



A high school in New Mexico, was closed for several days in June 1984 when a home economics teacher noticed the water in the potable system was yellow. City chemists determined that samples taken contained levels of chromium as high as 700 parts per million, "astronomically higher than the accepted levels of .05 parts per million." The head chemist said that it was miraculous that no one was seriously injured or killed by the high levels of chromium. The chemical was identified as sodium dichromate, a toxic form of chromium used in heating system boilers to inhibit corrosion of the metal parts.

No students or faculty were known to have consumed any of the water; however, area physicians and hospitals advised that if anyone had consumed those high levels of chromium, the symptoms would be nausea, diarrhea, and burning of the mouth and throat. Fortunately, the home economics teacher, who first saw the discolored water before school started, immediately covered all water fountains with towels so that no one would drink the water.

Investigation disclosed that chromium used in the heating system boilers to inhibit corrosion of metal parts entered the potable water supply system as a result of backflow through leaking check valves on the boiler feed lines.

Pesticide in Drinking Water

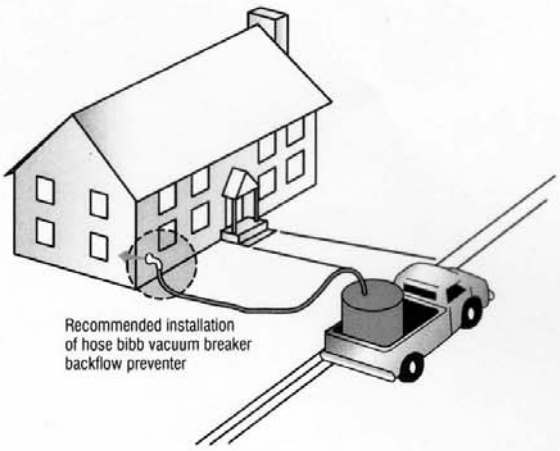
A pesticide contaminated a North Carolina water system in April, 1986, prompting the town to warn residents of 23 households not to drink the water. The residents in the affected area were supplied drinking water from a tank truck parked in the parking lot of a downtown office building until the condition could be cleared up. Residents complained of foul smelling water but there were no reports of illness from ingesting the water that had been contaminated with a pesticide containing chlordane and heptachlor.

Authorities stated that the problem occurred when a water main broke at the same time that a pest control service was filling a pesticide truck with water. The reduction in pressure caused the pesticide from inside the tank to be sucked into the building's water main. The pesticide contaminated the potable water supply of the office building and neighborhood area.

Car Wash Water in the Water Main Street

This car wash cross-connection and back-pressure incident, which occurred in February, 1979, in the state of Washington, resulted in backflow chemical contamination of approximately 100 square blocks of water mains. Prompt response by the water department prevented a potentially hazardous water quality degradation problem without a recorded case of illness.

Numerous complaints of grey-green and "slippery" water were received by the water department coming from the same general area of town. A sample brought to the water department by a customer confirmed the reported problem and preliminary analysis indicated contamination with what appeared to be a detergent solution. While emergency crews initiated flushing operations, further investigation within the contaminated area signaled the problem was probably caused by a car wash,



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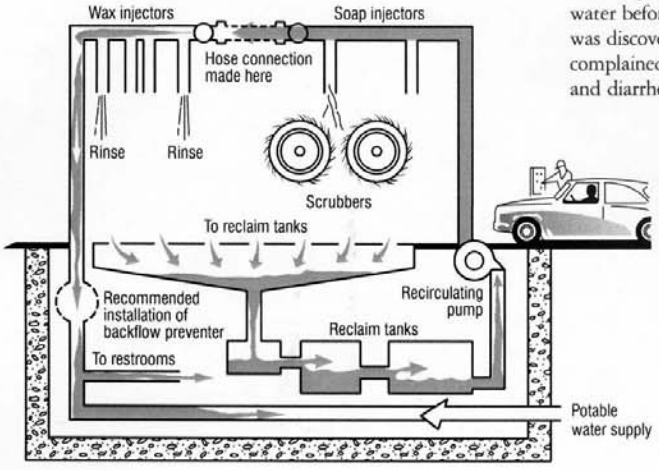
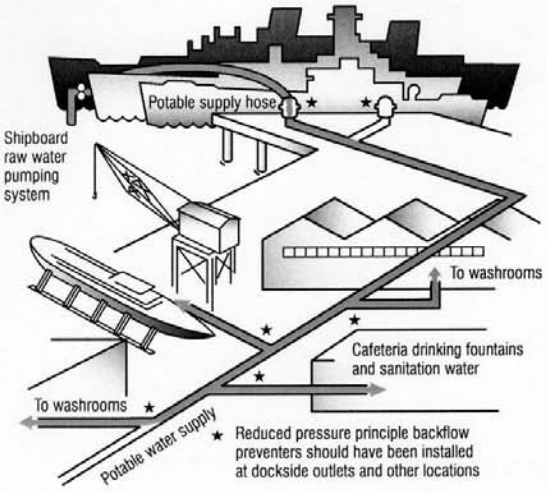
or laundry, based upon the soapy nature of the contaminant. The source was quickly narrowed down to a car wash and the proprietor was extremely cooperative in admitting to the problem and explaining how it had occurred. The circumstances leading up to the incident were as follows:

- On Saturday, February 10, 1979, a high pressure pump broke down at the car wash. This pump recycled reclaimed wash and rinse water and pumped it to the initial scrubbers of the car wash. No potable plumbing connection is normally made to the car wash's scrubber system.
- After the pump broke down, the car wash owner was able to continue operation by connecting a 2-inch hose section temporarily between the potable supply within the car wash, and the scrubber cycle piping.
- On Monday, February 12, 1979, the owner repaired the high pressure pump and resumed normal car wash operations. The 2-inch hose connection (cross-connection) was not removed!
- Because of the cross-connection, the newly repaired high pressure pump promptly pumped a large quantity of the reclaimed wash/rinse water out of the car wash and into a 12-inch water main in the street. This in turn was delivered to the many residences and commercial establishments connected to the water main.

Within 24 hours of the incident, the owner of the car wash had installed a 2-inch reduced pressure principle backflow preventer on his water service and all car wash establishments in Seattle that used a wash water reclaim system were notified of the state requirement for backflow prevention.



Shipyard Backflow Contamination



Water fountains at an East Coast Shipyard were posted "No Drinking" as workers flushed the water lines to eliminate raw river water that had entered the shipyard following contamination from incorrectly connected water lines between ships at the pier and the shipyard. Some third shift employees drank the water before the pollution was discovered and later complained of stomach cramps and diarrhea.

The cause of the problem was a direct cross-connection between the on-board salt water fire protection water system and the fresh water connected to one of the ships at the dock. While the shipyard had been aware of the need for backflow protection at the dockside tie up area, the device had not been delivered and installed prior to the time of the incident. As a result, the salt water on-board fire protection system, being at a greater pressure than the potable supply, forced the salt water, through backpressure, into the shipyard potable supply.

Fortunately, a small demand for potable water at the time of the incident prevented widespread pollution in the shipyard and the surrounding areas.

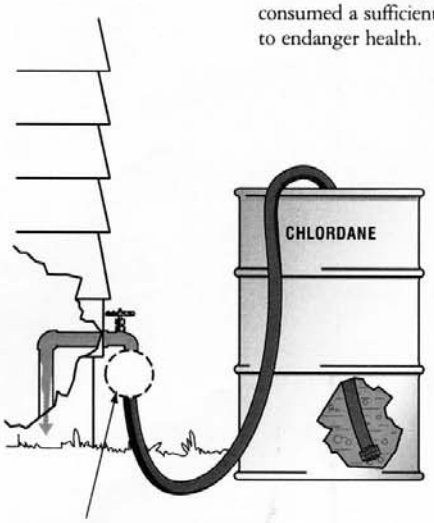
Source Document: United States Environmental Protection Agency's Cross-Connection Control Manual, February 2003 available at http://www.epa.gov/safewater/crossconnection.html

Chlordane in the Water Main

In October, 1979, approximately three gallons of chlordane, a highly toxic insecticide, was sucked back (back-siphoned) into the water system of a residential area of a good sized eastern city. Residents complained that the water "looked milky, felt greasy, foamed and smelled," and as one woman put it, "It was similar to a combination of kerosene and Black Flag pesticide."

The problem developed while water department personnel were repairing a water main. A professional exterminator, meanwhile, was treating a nearby home with chlordane for termite elimination. The workman for the exterminator company left one end of a garden hose that was connected to an outside hose bibb tap in a barrel of diluted pesticide. During the water service interruption, the chlordane solution was back-siphoned from the barrel through the house and into the water mains.

Following numerous complaints, the water department undertook an extensive program of flushing of the water mains and hand delivered letters telling residents to flush their lines for four hours before using the water. Until the water lines were clear of the contaminant, water was hand-hauled into homes, and people went out of their homes for showers, meals and every other activity involving potable water. Fortunately, due to the obvious bad taste, odor and color of the contaminated water, no one consumed a sufficient quantity to endanger health.



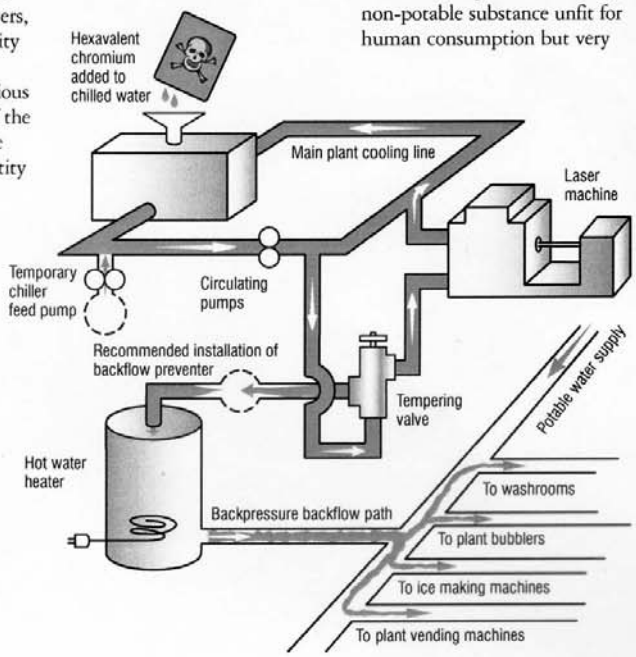
Recommended installation of hose bibb vacuum breaker backflow preventer

Hexavalent Chromium in Drinking Water

In July, 1982, a well meaning maintenance mechanic, in attempting to correct a fogging lens in an overcooled laser machine, installed a tempering valve in the laser cooling line, and inadvertently set the stage for a backpressure backflow incident that resulted in hexavalent chromium contaminating the potable water of a large electronic manufacturing company in Massachusetts employing 9,000 people. Quantities of 50 parts per million hexavalent chromium were found in the drinking water which is sufficient to cause severe vomiting, diarrhea, and intestinal sickness. Maintenance crews working during the plant shutdown were able to eliminate the cross-connection and thoroughly flush the potable water system, thereby preventing a serious health hazard from occurring.

The incident occurred as follows:

- Laser machine lenses were kept cool by circulating chilled water that came from a large refrigeration chiller. The water used in the chiller was treated with hexavalent chromium, a chemical additive used as an anticorrosive agent and an algicide. As a result, the chilled water presented a toxic, non-potable substance unfit for human consumption but very



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acceptable for industrial process water. No health hazard was present as long as the piping was identified, kept separate from potable drinking water lines, and not cross-connected to the potable water supply.

• A maintenance mechanic correctly reasoned that by adding a tempering valve to the chilled water line, he could heat up the water a bit and eliminate fogging of the laser lenses resulting from the chilled water being too cold. The problem with the installation of the tempering valve was that a direct cross-connection had been inadvertently made between the toxic chilled water and the potable drinking water line!

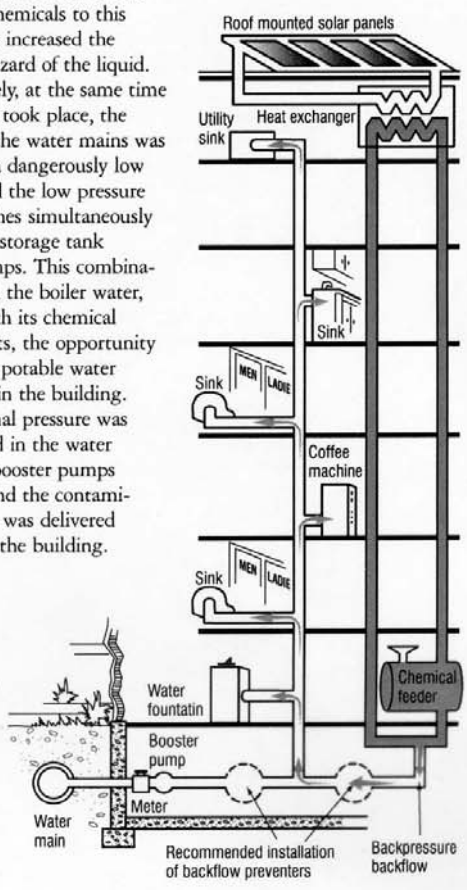
• Periodic maintenance to the chiller system was performed in the summer, requiring that an alternate chiller feed pump be temporarily installed. This replacement pump had an outlet pressure of 150 psi, and promptly established an imbalance of pressure at the tempering valve, thereby overpressurizing the 60 psi, potable supply. Backpressure backflow resulted and pushed the toxic chilled water from the water heater and then into the plant's potable drinking water supply. Yellowish green water started pouring out of the drinking fountains, the washroom, and all potable outlets.

Employee Health Problems due to Cross-Connection

A cross-connection incident occurring in a modern seven-story office building located in a large city in New Hampshire, in March, 1980, resulted in numerous cases of nausea, diarrhea, loss of time and employee complaints as to the poor quality of the water.

On Saturday, March 1, 1980, a large fire occurred two blocks away from a seven-story office building in this large New Hampshire city. On Sunday, March 2, 1980, the maintenance crew of the office building arrived to perform the weekly cleaning, and after drinking the water from the drinking fountains, and sampling the coffee from the coffee machines, noticed that the water smelled rubbery and had a strong bitter taste. Upon notifying the Manchester Water Company, water samples were taken and preliminary analysis disclosed that the contaminants found were not the typical contaminants associated with fire line disturbances. Investigating teams suspected that either the nearby fire could have siphoned contaminants from adjacent buildings into the water mains, or the contamination could have been caused by a plumbing deficiency occurring within the seven story building itself.

Water ph levels of the building water indicated that an injection of chemicals had probably taken place within the seven-story building. Tracing of the water lines within the building pinpointed a 10,000 gallon hot-water storage tank that was used for heat storage in the solar heating system. It did not have any backflow protection on the make-up supply line! As the storage tank pressure increased above the supply pressure, as a result of thermal expansion, the potential for backpressure backflow was present. Normally, this would not occur because a boost pump in the supply line would keep the supply pressure to the storage tank always greater than the highest tank pressure. The addition of rust inhibiting chemicals to this tank greatly increased the degree of hazard of the liquid. Unfortunately, at the same time that the fire took place, the pressure in the water mains was reduced to a dangerously low pressure and the low pressure cutoff switches simultaneously shut off the storage tank booster pumps. This combination allowed the boiler water, together with its chemical contaminants, the opportunity to enter the potable water supply within the building. When normal pressure was reestablished in the water mains, the booster pumps kicked in, and the contaminated water was delivered throughout the building.



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Dialysis Machine Contamination

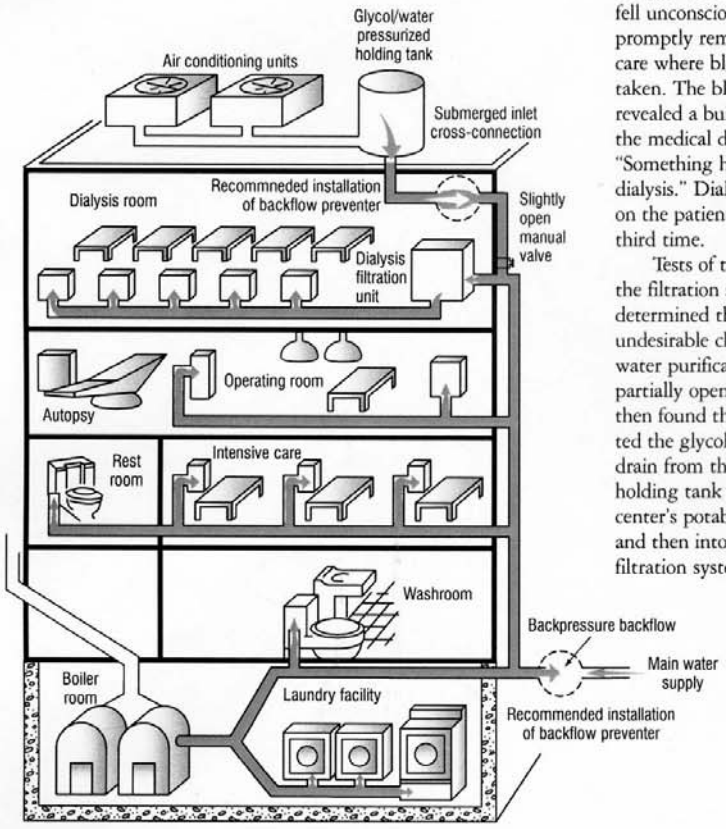
Ethylene glycol, an anti-freeze additive to air conditioning cooling tower water, inadvertently entered the potable water supply system in a medical center in Illinois in September, 1982, and two of six dialysis patients succumbed as a direct or indirect result of the contamination.

The glycol was added to the air conditioning water, and the glycol/water mix was stored in a holding tank that was an integral part of the medical center's air conditioning cooling system. Pressurized make-up water to the holding tank was supplied by a medical center potable supply line and fed through a manually operated control valve. With this valve open, or partially open, potable make-up water flowed slowly into the glycol/water mixture in the holding tank until it filled to the point where the pressure in the closed tank equaled the pressure in the potable water supply feed line. As long as the potable feed line pressure was at least equal to, or greater than, the holding tank pressure, no backflow could occur. The stage was set for disaster, however.

It was theorized that someone in the medical center flushed a toilet or turned on a faucet, which in turn dropped the pressure in the potable supply line to the air conditioning holding tank. Since the manually operated fill valve was partially open, this allowed the glycol/water mixture to enter the medical center potable pipelines and flow into the dialysis equipment. The dialysis filtration system takes out trace chemicals such as those used in the city water treatment plant, but the system could not handle the heavy load of chemicals that it was suddenly subjected to.

The effect upon the dialysis patients was dramatic: patients became drowsy, confused and fell unconscious, and were promptly removed to intensive care where blood samples were taken. The blood samples revealed a build-up of acid and the medical director stated that, "Something has happened in dialysis." Dialysis was repeated on the patients a second and third time.

Tests of the water supply to the filtration system quickly determined the presence of "an undesirable chemical in the water purification system." The partially open fill valve was then found that it had permitted the glycol water mix to drain from the air conditioning holding tank into the medical center's potable supply lines and then into the dialysis filtration system equipment.



Creosote in the Water Mains

Creosote entered the water distribution system of a southeastern county water authority in Georgia, in November, 1984, as a result of cross-connection between a ¾-inch hose that was being used as a priming line between a fire service connection and the suction side of a creosote pump. The hose continually supplied water to the pump to ensure the pump was primed at all times. However, while repairs were being made to a private fire hydrant, the creosote back-siphoned into the water mains and contaminated a section of the water distribution system.

Detailed investigation of the cause of the incident disclosed that the wood preservative company, as part of their operation, pumped creosote from collective pits to other parts of their operation. The creosote pump would automatically shut off when the creosote in the pit was lowered to a predetermined level. After the creosote returned to a higher level, the pump would restart. This pump would lose its prime quite often prior to the pit refilling, and to prevent the loss of prime, the wood preservative company would connect a hose from a ¾-inch hose bibb, located on the fire service line, to the suction side of the pump. The hose bibb remained open at all times in an effort to continuously keep the pump primed.

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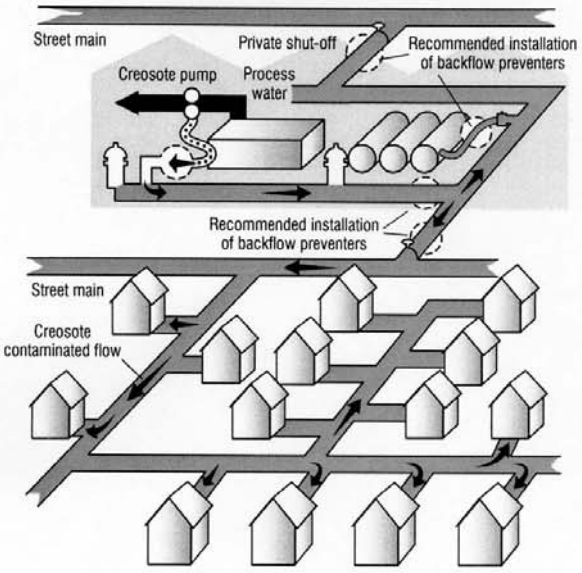

Repairs were necessary to one of the private fire hydrants on the wood preservative company property, necessitating the shutting down of one of two service lines and removal of the damaged fire hydrant for repair. Since the hydrant was at a significantly lower level than the creosote pit, the creosote back-siphoned through a ¾-inch pump priming hose connecting the creosote pit to the fire service line.

After the repairs were made to the hydrant, and the water service restored, the creosote, now in the fire lines, was forced into the main water distribution system.

Kool-Aid Laced With Chlordane

In August, 1978, a professional exterminator was treating a church located in a small town in South Carolina, for termite and pest control. The highly toxic insecticide chlordane was being mixed with water in small buckets, and garden hoses were left submerged in the buckets while the mixing was being accomplished. At the same time, water department personnel came by to disconnect the parsonage's water line from the church to install a separate water meter for the parsonage. In the process, the water was shut off in the area of the church building. Since the church was located on a steep hill, and as the remaining water in the lines was used by residents in the area, the church was among the first places to experience a negative pressure.

The chlordane was quickly siphoned into the water lines within the church and became mixed with the Kool-Aid being prepared by women for the vacation bible school. Approximately a dozen children and three adults experienced dizziness and nausea. Fortunately, none required hospitalization or medical attention.

Source Document: United States Environmental Protection Agency's Cross-Connection Control Manual, February 2003 available at http://www.epa.gov/safewater/crossconnection.html