Chapter 1
Safety of Water

Introduction

This chapter relates to the source and transport of water that comes into contact with food or food contact surfaces or is used in the manufacture of ice. Cross-connections between potable and non-potable water systems are also discussed.

A primary safety concern for any food processing operation should be the safety of water. A complete SSOP plan must first account for the sources and treatment of water that comes in contact with food or food contact surfaces or is used to make ice. It must also consider cross-connections between the safe water supply (potable water) and any unsafe or questionable water supply (non-potable) or sewer disposal systems. In seafood processing plants, cross-connections have been found in many places, such as, hard plumbing between potable and non-potable water lines; unprotected hose bibs (i.e., those with no backflow prevention devices); hoses lying in pooled water or submerged in wash tanks; or metering pumps used for cleaning chemicals without a backflow prevention device.

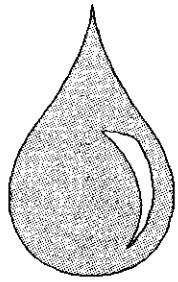
1-1. Key Sanitation Condition No. 1:

- Safe supply for water that contacts food and food contact surfaces;
- Safe water supply for production of ice; and
- No cross-connections between potable and non-potable water.

Water is of major importance because of its broad use and application in food processing. It is used: 1) as an ingredient in some seafood products; 2) to convey or transport products; 3) to wash foods; 4) to clean and sanitize facilities, utensils, containers, and equipment; 5) to make ice and glazed products; and 6) for drinking. All of these require safe water that will not cause contamination of the food.

1-2. Water is one of the most important components of a seafood establishment since it is used:

- As an ingredient;
- To convey or transport products;
- To wash foods;
- To make ice and glazed products;
- To clean and sanitize facilities, utensils, containers and equipment; and
- For drinking.



The current Good Manufacturing Practices (GMP) Regulation (21 CFR Part 110) states that the water supply in a food processing plant shall be sufficient for the operations intended and shall be derived from an adequate source; and any water that contacts food or food-contact surfaces shall be safe and of adequate sanitary quality. In most instances, the "adequate supply . . . of adequate sanitary quality" has been interpreted to mean from a 'potable' water supply based on certain nationally established drinking water standards. An 'approved' source is most often determined by local and state regulatory guidelines. These local guidelines can address water obtained from public or municipal sources, private sources (wells), and coastal waters (seawater). State authorities often reference the "National Primary Drinking Water Standards" established by the U.S. Environmental Protection Agency (EPA). Additional information including the intended uses are considered in evaluating well water and seawater sources.

Monitoring - Sources

1-3. Common sources for water used in seafood processing:

- Municipal;
- Private wells; and
- Seawater.

Whether water is obtained from a public or municipal source, private well, or as seawater, the supply must be monitored with sufficient frequency to assure that the water is safe for use on foods and food contact surfaces.

Municipal Water

If water comes from a municipal source, a copy of the water bill will usually be sufficient documentation for an approved water supply (1-4). This seems simple, and it is. Although it is not required, it may also be helpful to request a copy of the municipality water quality analysis. In addition to water safety information, this analysis may reveal information (e.g., water hardness and mineral content) that could influence processing conditions other than food safety. The water bill and analysis should be obtained annually and filed with a periodic or monthly Sanitation Control Record (Form 1-4). Some firms may choose to perform additional analyses and store the results in their periodic sanitation records.

1-4. Periodic sanitation control record

Monthly Sanitation Control Record

Report Date: 1/21/99

Firm Name: Any Seafood Co., Inc

Firm Address: Anywhere, USA

Sanitation Area	Decision	Comments/ Corrections
1) Safety of Water ◆ Safe and sanitary source (S/U) (annual) ◆ No cross-connections in hard plumbing (S/U)	S U	Municipal water bill and analysis on file (1/10/99) Requested installation of air gap in water line used to fill new thaw tank
2) Condition and Cleanliness of Food Contact Surfaces ◆ Processing equipment and utensils in suitable condition (S/U)		
3) Prevention of Cross-contamination ◆ Physical conditions of plant and layout equipment (S/U)		

S = Satisfactory / U = Unsatisfactory, requires correction

Additional Comments:

Air gap installed 1/22/99

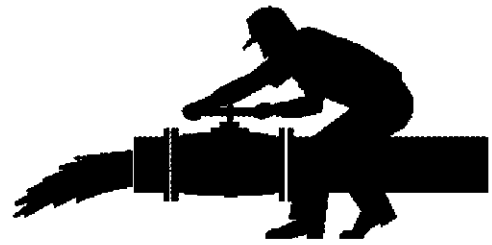
Signature or initials BSJ

Private (Well) Water

Likewise, private water sources should be monitored to determine if the water meets approved standards. This requires laboratory analysis, which at a minimum should include testing for indicator bacteria such as total coliforms. For example, well water testing should be conducted before any new source is used for processing operations, then at least on a semi-annual basis or more frequently for suspect sources. The frequency for sampling will usually be specified by the local or state requirements. These same authorities or locally approved water testing labs can provide instructions for the proper sampling methods and test procedures. Sampling methods must consider proper choice of the sampling site, proper sampling procedures, and prompt handling and transport of the sample.

1-5. Private water monitoring:

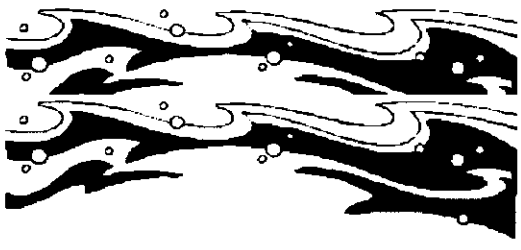
Private water monitoring should be conducted before any new service is used for processing operations and then at least on a semi-annual basis or more frequently for suspect sources in accordance with state requirements.



Seawater

It is reasonable to expect the water safety considerations for use of seawater for processing should at least match the considerations for potable water from municipal and private sources. For this reason, the company or vessel using seawater to process fish and fishery products should consider monitoring the original source, the water after any necessary treatments, and water from storage tanks. Realizing that seawater conditions can change due to seasons and coastal activities, monitoring could be more frequent than for land-based municipal or private sources. Although the water will contain higher amounts of salts than found in freshwater, the saltwater used on food and food contact surfaces must at least meet the safety requirements for drinking water. In situations where it does not, careful consideration must be given to the safety and aesthetic risks associated with its use.

For example, testing may not be needed when seawater is simply used to offload whole fish from vessels using pumps or flumes. However, when seawater is used for processing and comes into direct contact with fillets or the edible parts of other seafood products, seawater sources need to be more carefully monitored. This monitoring could include testing, depending on local conditions (i.e., red tides) and water quality.



1-6. Sea water monitoring:

Monitoring for seawater safety in processing should be conducted more frequently than for land-based municipal or private sources. The guidelines should be in accordance with state requirements and locally approved testing labs.

Monitoring - Plumbing

Monthly monitoring is also usually adequate for problematic cross-connections in hard (permanent) plumbing between the potable water lines and non-potable water or sewer lines. More frequent (e.g., daily) monitoring is required to prevent potential water contamination from cross-connections created by back siphonage or improper use of hoses (e.g., direct submergence in tanks; lying on the floor). Cross-connection problems due to back siphonage should be monitored and recorded before processing (Pre-Op). Any problems should be immediately corrected and so recorded in a Daily Sanitation Control Record (1-7). The most effective remedy for back siphonage or backflow is a simple air gap (space) between the water source and the tank, holding container, or water on the floor. Wherever this is not practical, vacuum breakers of several types are available to prevent backflow. Whenever malfunctioning vacuum breakers are discovered, they must be repaired or replaced immediately and the correction noted in the Daily Sanitation Control Records. In most areas, specific local public health ordinances specify under what conditions and in what manner they must be used.

Monitoring - Ice

In addition to monitoring for the safety of the water source and associated plumbing, periodic monitoring should be conducted for the safety of the ice made from the water supply. Ice and its storage and handling conditions can be responsible for spreading problematic bacteria. This situation usually results from contamination of the ice as a result of insanitary storage, conveying, shoveling, or contact with floors. These sanitary conditions involve indirect food contact surfaces which are discussed in Chapter 2 as part of the required monitoring for the condition and cleanliness of food contact surfaces.

Corrections

When monitoring detects a problem with the processing water source, the processor must evaluate the situation and, if necessary, discontinue use of water from that source until the problem is solved and retesting confirms that it no longer exists. Additionally, the need to take action regarding any and all products produced under the adverse conditions must be assessed.

When monitoring detects cross-connections in the hard plumbing, the problem must be corrected immediately. If the problem portion of the water supply cannot be isolated (e.g., use of a shutoff valve), processing should be discontinued until the repair can be made. Additionally, product processed under the deficient conditions must be withdrawn from distribution until their safety has been established.

When monitoring detects the absence of a vacuum breaker on a hose bib or some other condition that could lead to back siphonage, the condition must be corrected as soon as practical and immediate action must be taken to prevent contamination. All repairs and other corrections must be recorded on the appropriate Daily Sanitation Control Record.

Records

Sanitation control records are necessary to document that the processor is consistently conforming to sanitary conditions and practices. The actual records will vary to accommodate differences in processing operations. The example provided at 1-4 is a Periodic Sanitation Control Record completed on 1/21/99. The processor chose to attach a copy of that month's municipal water bill and a copy of the

municipal water supplier's water analysis to the record. The processor noted on the record that the attached bill and analysis were filed. This is ample documentation of the adequacy of the water source. If a private water source or seawater were used in the operations, the results of the water testing would also be recorded on this form. Test results should be recorded and stored. If any contamination is indicated, corrections and retesting results should be recorded and stored with the appropriate Sanitation Control Record.

The record also includes a check mark indicating that the processor had performed a monthly check for the presence of cross-connections in the hard plumbing. In addition, the Daily Sanitation Control Record provided at 1-7 includes the daily pre-op check for potential back siphonage conditions, especially those related to hoses.

Note, records for the sanitary conditions for ice, ice storage, and ice handling would be according to the daily monitoring for food contact surfaces (Chapter 2).

I-7.

DAILY SANITATION CONTROL RECORD

Report Date: 10/22/99

Firm Name: Any Seafood Co., Inc.

Firm Address: Anywhere, USA

Line 1: Raw Seafood (not ready-to-eat)
Line 2: Ready-to-eat

Sanitation Area and Goal	Pre-Op Time:	Start Time:	4 Hour Time:	8 Hour Time:	Post-Op Time:	Comments and Corrections
	7:35A					
1) Safety of Water (See Monthly Sanitation Control Record) ◆ Back Siphonage-Hoses (S/U)	U					Replaced backflow preventor on hose faucet #3
2) Condition and Cleanliness of Food Contact Surfaces (See Monthly Sanitation Control Record) ◆ Equipment cleaned and sanitized Line 1: (S/U) Line 2: (S/U)						
◆ Sanitizer Strength Sanitizer Type:_____ Strength:_____ ppm Line 1: (ppm) Line 2: (ppm)						
◆ Gloves and aprons clean and in good repair Line 1: (S/U) Line 2: (S/U)						
3) Prevention of Cross-Contamination (See Monthly Sanitation Control Record) ◆ Hands, gloves, equipment, and utensils washed/sanitized after contact with unsanitary objects (S/U)						
◆ Employees working on raw products, wash and sanitize hands/ gloves/outerwear before working with cooked products (S/U)						
◆ Unpackaged cooked products separated from raw products (S/U)						

S = Satisfactory / U = Unsatisfactory

Background

Water Standards

The National Primary Drinking Water Regulations established by the U.S. Environmental Protection Agency are legally enforceable standards that apply to public water systems. They are developed to protect public health. These standards are commonly referenced by state and local authorities in establishing regulatory guidelines and requirements for all water supplies or sources, both fresh or salt, used in food processing. They contain limits or maximum contaminants levels (MCL) for numerous organic and inorganic chemicals (e.g., lead, mercury; dioxin and PCBs). Likewise, they list the MCL for certain microorganisms. The most notable and commonly used microbial limit is for total coliforms, including fecal coliform and *E. coli*. These bacteria are used as a measure or indicator for other potentially harmful bacteria that may be present. They are a common indicator for potential water contamination from human or animal fecal waste.

1-8. EPA National Drinking Water Regulations for Microorganisms

	MCL Goal	MCL*
Total coliforms (including fecal coliforms & *E. coli*)	zero	5%**
viruses (enteric)	zero	99.99% killed or inactivated
Giardia lamblia	zero	99.99% killed or inactivated

*MCL - Maximum Contamination Level

**No more than 5.0% of the water samples total coliform-positive in a month. Every sample that has total coliforms must be analyzed for fecal coliforms. The presence of any fecal coliforms is unacceptable in drinking water.

Total coliforms can be found in the water environment and are generally not harmful. However, water treatment is necessary to remove coliforms from water used for drinking or direct food contact. The presence of these bacteria in drinking water is generally a result of a problem with water treatment or the pipes that distribute the water, and indicates that the water may be contaminated with harmful organisms. Total coliforms are not only a useful indicator of potential sewage contamination, but are also a useful screen for the actual presence of problematic coliforms like *E. coli*. The presence of *E. coli* is strong evidence that fresh sewage is present in the water.

Total coliforms are not a perfect indicator of the actual or potential presence of harmful organisms. Some disease-producing organisms, especially the protozoa such as *Giardia* and *Cryptosporidium*, are able to withstand treatments that remove total coliforms. These two protozoa can be found in surface waters contaminated by human sewage or wildlife. The principal viruses that cause problems in water (i.e., hepatitis A and Norwalk agent) can be associated with fecal contamination. Chlorination normally inactivates these viruses.

Water Sources

Municipalities are the most common source of water for processing fish and fishery products. It is often the more expensive source, but cost must be weighed against safety, quality and availability. Municipal water typically maintains high quality standards for both chemical and microbiological content; it usually has been purified or treated; and it is tested on a pre-determined schedule.

1-9. Most common water source obtained from municipalities have:

- ◆ High chemical and microbiological standards;
- ◆ Been purified or treated; and
- ◆ Been tested on a pre-determined schedule.

Private water can come from a variety of surface sources, but it is most often obtained from wells. Wells are drilled by food plants to provide less costly, more reliable, or higher quality water than might be available locally. Properly maintained, wells can provide clean water that assures high quality and food safety, but they are often more subject to contamination than most municipal sources. Well water may contain a higher amount of dissolved minerals, undissolved solids, organic matter, dissolved gases, and microorganisms than municipal water. Chemical and microbiological contamination of well water can occur from a variety of sources. Sewage can enter wells if they are flooded or are located too close to cesspools, septic tanks, or associated drainage fields. Well casings or linings that are cracked or improperly sealed may leak and allow contamination. Floods or heavy rains, which occur frequently in coastal areas where seafood processing facilities are commonly located, also can allow surface water to enter the well and produce contamination. Similarly, surface debris can enter wells unless adequate protection is provided. One other source of contamination is the ground water itself, which may enter the well without sufficient natural filtration and percolation to remove impurities. Chemical pollution of wells has occurred through leaking fuel tanks; the application of agricultural chemicals on farms, home gardens, and golf courses; and industrial discharges.

Well water may or may not be less contaminated than water from other sources. The decision on whether or not to add disinfecting chemicals must be based on microbiological tests which can be performed by either local health agencies or private laboratories. In many cases, local public health authorities can also provide information on the proper and legal construction of wells. For example, Virginia authorities recommend that the well head should be located about 2-3 feet above the surface and the ground sloped away from the casing to prevent entry of surface water. Sources of sewage and landfills should be at least 200 feet distant, depending on the soil condition and rate of water movement through it. Well casings should be welded or threaded to prevent entry of surface water and they should be sealed to a concrete curb at least 24 inches high in order to prevent contamination from surface water. A screened or filtered vent must be provided to prevent a vacuum from forming within the well that could draw in contamination. Water should never be drawn from a level of less than 10 feet below the surface.

1-10. Chemical and microbiological contamination of well water can occur due to:

- ◆ Flood or heavy rains;
- ◆ Location too close to cesspools, septic tanks, agricultural sites, or associated drainage fields; or
- ◆ Cracked or improperly sealed well casings or liners.

The use of **seawater** in processing is usually limited to some remote coastal locations and certain processing vessels. In some situations it has been drawn from local, active harbors. As a natural source subject to daily and seasonal conditions, and environmental contamination, the safety and quality of the water may be questionable. In these situations, treatment, such as chlorination or restricted uses may be sufficient to eliminate microbial concerns. For example, use can be restricted to primary processing steps that do not influence food safety (e.g., fluming whole fish), to be followed by further processing and wash steps with a potable water supplied from a reservoir or storage tank. Because salt and corrosion can also influence product quality, flavor and appearance, their influence must also be considered when determining the use of seawater in processing operations.

In addition, when operating in an area where there is a visible oily sheen on the water, or where oil can be seen on the beaches adjacent to the water a processor, or operator of a fish processing vessel should **not** take on sea water for (1) fluming, pumping, unloading, or chilling seafood; (2) holding live seafood products, or; (3) cleanup purposes. The intakes for the seawater tanks on processing vessels should be located near the bow whenever possible, and on the opposite side of the keel from any domestic and processing waste discharge points. Vessels, at anchor, should swing from a bow anchor to minimize the possibility of pulling contaminated water into the seawater intake system.

Seawater used in contact with foods and food contact surface should meet similar potable water guidelines required for municipal and private water sources. The World Health Organization (WHO) defines 'clean sea water' as seawater which meets the same microbiological standards as potable water and is free from objectionable substances. Potable water is defined by the drinking water standards established by EPA.

1-11. World Health Organization's recommendations:

(WHO) defines 'clean sea water' as seawater which meets the same microbiological standards as potable water and is free from objectionable substances.

In accordance with the previously stated requirements for potable water, seawater would be subject to monitoring and possible treatment to remove microorganisms before use in processing opera-

tions. In addition to concerns for bacterial contaminants, natural seawater may also contain chemical pollutants from coastal or ship activity, and natural toxins (e.g., red tides). For these reasons, the monitoring for seawater safety should be more extensive and frequent than used for land-based sources.

According to potable water requirements of the Vessel Sanitation Program developed for passenger ships by the Centers for Disease Control (CDC), water monitoring on these vessels should also include frequent measures for treatment with free halogen residuals (e.g., chlorine content). These guidelines would apply to all vessel water, fresh or salt, used for contact with food and food contact surfaces.

1-12. Passenger Vessel Sanitation Program Guidelines for Potable Water Use

Source:	Potable according to EPA's National Primary Drinking Water Regulations
Treatment:	Halogen level (e.g., free chlorine content) greater than 0.2 mg/liter (ppm) and less than 5.0 ppm.
Monitoring:	Minimum of four samples per month to assure zero *E. coli.*
Storage:	Tanks do not share common walls with the vessel hull or with tanks containing non-potable water or other liquids; interior tank coatings approved for potable water contact (non-corrosive); tank vents and overflows protected from contamination; and device used to check tank water depth will not contaminate.
Piping:	Must be colored (blue) and labeled for potable water use; no potable water piping to pass under or through sewage or other tanks holding non-potable liquids; no non-potable piping passing through or under tanks holding potable water.
Hoses:	Colored and labeled for potable water use only; unique hose fillings from all other hose fillings, flush before use and drain after use.

Source: Vessel Sanitation Program Operations Manual, 1999.
Centers for Disease Control and Prevention - VSP, Atlanta, GA

In-Plant Water Contamination

Caution must be exercised to avoid contamination of the potable water system with fluids from other sources. This type of contamination may occur as a result of cross-connections, backflow, or back siphonage. These problems can result from improper installations, altered plumbing and additions to the existing plumbing. Also, submerged inlets can result from the improper placement of unrestricted pipe intakes or open hoses. In some cases, the problems may result because the plumber doing the installation or modification was unaware of the potential water quality problems.

1-13. Causes of In-Plant Water Contamination

- ◆ Cross-Connections
- ◆ Backflow
  - back pressure
  - back siphonage

Cross-connections occur when the plumbing allows potable water to mix with any non-potable water, particularly sewage, or other liquids. The cross-connection can be a direct link between the sources or an indirect link whereby the contaminating source is sucked or forced into the potable source. Examples of indirect links include faucets positioned below toilet bowls or wash tanks, and submerged inlets. According to plumbing guidelines, a submerged inlet is any unrestricted connection to a fixture (e.g., pipe or hose) with an opening positioned less than two diameters above the highest level possible for the potable water or potential contaminating liquid. For example, an open hose submerged in a tank of water.

Backflow problems occur when pressure differences in the water distribution system forces contaminants into the potable water supply. It can result as 'back pressure' pushing contaminants into the potable supply or 'back siphonage' when the pressure in the potable water supply is less (negative pressure) than atmospheric pressure. Differences in pipe sizes, water flow rates, and water levels create these problems.

Usually a well-designed and properly maintained air gap is the best means available to protect against backflow problems. Plumbing guidelines recommend air gaps twice the effective opening of the potable water outlet diameter and the gap should be at least one inch. For example, most local authorities require air breaks on water lines inside toilet tanks.

When air gaps are not possible, vacuum beakers can be used to allow atmospheric pressure to enter the piping system to eliminate any vacuum pulling liquids into the potable supply. Vacuum beakers come in two types; pressure and non-pressure. A qualified plumber should be aware of the proper selection and placement depending on the pipe/faucet configurations and water use. Monitoring and qualified checks or installation should become part of a periodic sanitation control record.

1-14. Backpressure can be a source of contamination when

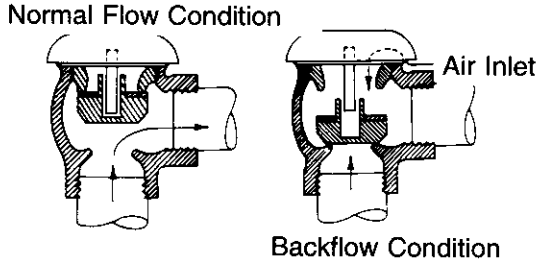
- ◆ A potable water system is connected to a system operating under a higher pressure by means of a pump, boiler, elevation difference, or air or steam pressure.

One other potential source of water contamination in the food environment deserves mention: water softening or deionizing devices. Often this source of contamination is first suspected when water has an off-odor or flavor. Total plate counts will be extremely high, and in fact, the water may even be turbid (cloudy) as a result of the high numbers of bacteria that it contains. Despite this condition, tests for total coliforms will usually be negative. Although the microorganisms that are likely to grow in deionizers are nonpathogenic, their presence is undesirable, and every effort should be made to prevent their growth. Frequent back flushing of the resin bed, and periodic resin bed replacement is the most satisfactory means of controlling contamination.

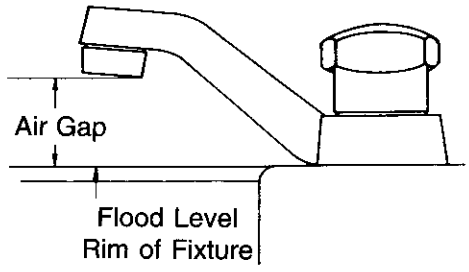
1-15. Backflow control:

- Air gap
- Vacuum breaker
- Check valve

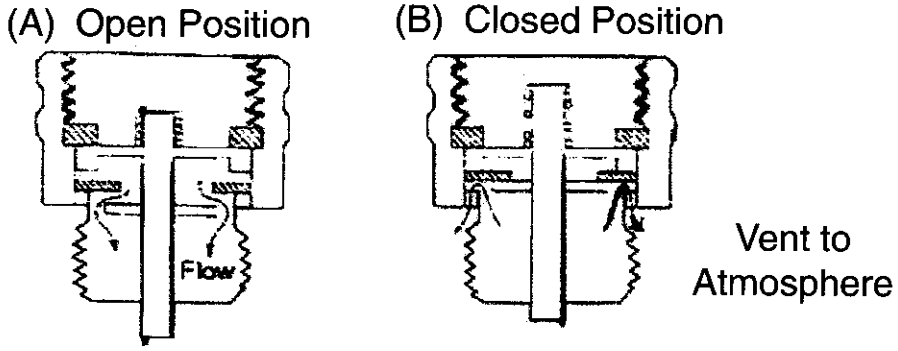
Atmospheric Vacuum Breaker



Air Gap and Effective Opening



Operation of a Hose Connection Vacuum Breaker



1-16.

Sanitation Control Guide

Entry date:	Water Quality	FDA Key Condition No. 1

Concern: Safety of Processing Water and Ice

Examples:
Municipal water supply suspect or not routinely checked. Well water supply suspect or not routinely checked.

Controls and Monitoring:

Obtain copies of municipal water bills and document their verification procedures. **Frequency: Before initiating business, then one monthly billing as annual evidence of service.**

For well water conduct water tests for total coliforms and/or other attributes prescribed by local authorities. **Frequency: Before initiating business, then semi-annual or as advised by local authorities.**

(Note: Quality of ice used in contact with seafoods depends on the quality of the water and the cleanliness and condition of the ice storage area which is monitored as a contact surface in FDA Key Condition No. 2.)

Recommended Corrections:
Maintain file of municipal water bills. Stop use of any contaminated water until properly treated and retested.

Records:
Monthly & Semi-Annual Sanitation Control Records

1-17.

Sanitation Control Guide

Entry date:	Cross-Connections in Hard Plumbing and Back siphonage-hoses	FDA Key Condition No. 1

Concern: Safety of Processing Water and Ice

Examples:
Improper plumbing connections could allow mixing of potable water and waste water. Hoses and faucets on water outlets are submersed in tanks, flumes, or hoppers used to hold, move, thaw or wash product during processing.

Controls and Monitoring:

Check plumbing installations, flow patterns and conditions to determine any potential problems with cross-connections or backflows. **Frequency: Immediately following new installation or changes, and semi-annually.**

Check plumbing installations and all water outlets to provide air gaps or backflow prevention devices. **Frequency: Immediately after new installations and changes, daily pre-ops, and semiannual for entire plant operations.**

Recommended Corrections:
Immediately correct any cross-connections and determine any potential contamination of product that may need to be reprocessed, recalled or destroyed. Install proper air gaps and backflow prevention devices.

Records:
Daily Sanitation Control Records for installations, changes and pre-ops
Monthly Sanitation Control Records for semiannual checks

References

American Water Works Association. 1990. Recommended Practice for Backflow Prevention and Cross-Connection Control. AW WA Manual M14a-92. Second Edition. Denver, CO. 124 pp.