Centers for Disease Control and Prevention
National Center for Environmental Health
Vessel Sanitation Program

Health Practices on Cruise Ships: Training for Employees
Transcript

# Cross Connection Control

The Centers for Disease Control and Prevention Vessel Sanitation Program is proud to present to you the following session: Cross Connection Control. While this presentation is primarily intended for cruise vessels under the jurisdiction of the Vessel Sanitation Program, it may also be used for anyone interested in this topic. This session should not be used as a replacement for existing interactive training, but should be used as an adjunct to a comprehensive training program.

Protecting the potable water system your vessel. Learning objectives: at the end of this session, you should be able to describe the differences between backpressure and backsiphonage, list the type of protection devices acceptable for backpressure and backsiphonage, list what must be considered prior to selecting the appropriate form of protection for a cross-connection, and describe the difference between a contaminant and a pollutant.

This slide is a pie chart representation of waterborne outbreaks caused by distribution system deficiencies between 1971 and 2000. The legend on the right hand side indicating the blue section is 51% of these deficiencies were caused by cross-connections or backsiphonage.

Identification of potable water lines and fittings. You need to paint or stripe unique blue at five meter or 15 feet intervals. This is represented on ISO14726, which we will show later. Paint on both sides of partitions, bulkheads, and decks. You don't want to be moving through a vessel, trying to identify water lines, and come around a bulkhead and find that there is no identification on the other side. No blue should be painted on piping downstream of any reduced pressure devices. This is because anything past the reduced pressure device is no longer a protected water system. Although this chart indicates different coloring schemes for all the piping on a vessel, VSP only requires unique striping blue on water distribution system piping.

Potable water system free of cross-connections. A cross-connection is defined as an actual or potential connection between a potable water system and any nonpotable source.

Backflow. Backflow is the undesirable reversal of flow of water or other substance into the potable water distribution system. This can happen through backsiphonage or backpressure.

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Backsiphonage is a negative pressure in the piping system. In this instance, we're depicting a hose hooked to a faucet emptied into a bucket where the end of the hose is below the water system in the bucket. If there is a negative pressure in the piping system on the vessel, this hose will act as a straw, sucking whatever is in that bucket back up into the distribution system. If these are chemicals or some other contaminant, and it recharges the system later on, it would spread this throughout the distribution system in that area of the vessel.

Backpressure. Backpressure is defined as pressure in downstream piping greater than the supply pressure. An example of this would be the fire system where you have pumps on the line. If those pumps were to kick in, you would increase the pressure in that side of the line and pump water back into the feed lines. This is why we have reduced pressure principle backflow requirement on the fire lines entering the vessel.

Types of cross-connection. There are direct cross-connections, and those are under the influence of backpressure and backsiphonage. And then indirect cross-connections are only subject to backsiphonage. Types of backflow prevention are non-mechanical and mechanical.

Air gap, non-mechanical. This slide represents an air gap, which is a physical separation. This separation has to be two pipe diameters or 2.54 centimeters, whichever is greater. For example, if I had a pipe that was one-quarter inch, two pipe diameters would be only a half inch. One inch would be required. This is the highest form of protection. Air gap alternatives are a barometric loop or anti-siphon loop.

Mechanical device options: noncontinuous pressure devices, continuous pressure devices, health hazard, non-health hazard, backpressure, backsiphonage, others.

Non-continuous pressure. Hose bib backflow preventer with a single check valve, an example of a non-continuous pressure type device. This device is usually seen on hose bibs on deck taps on vessels. However, you cannot have a valve downstream such as a spray nozzle on the end of the hose.

Non-continuous pressure. Vacuum breaker. This is an example of a hose bib vacuum breaker. As you can see in this slide, when water pressure is applied, it pushes open the check valve system, allowing water to flow around and out through the hose. Once pressure is relieved or the valve is turned off, the spring pushes the check valve back up into place, sealing it off and allowing the water to vent around the outside of the unit.

Atmospheric vacuum breaker assembly, AVB. Atmospheric vacuum breaker assembly can be used for health hazard or non-continuous pressure application, and protects against backsiphonage only. In a non-continuous pressure situation, it cannot be used for greater than 12 hours in any 24-hour period.

This is an example of an AVB. This is the inlet side, the outlet side. As I turn it over, we have a cutaway view. This is the inlet, and as water is applied, it pushes the plunger up and seals it off, allows flow to go to the outlet. Once water pressure is relieved, gravity will allow the plunger to drop back down into place and keep backsiphonage from occurring. The reason we don't want to use this more than 12 hours out of a 24-hour period, if this is sealed for too long, the rubber gasket may adhere to the top surface, and would not drop down once the pressure is relieved.

Continuous pressure type backflow preventers. These are double check valve units. They have an intermediate atmospheric vent, and are used in low hazard situations. Some are described here or pictured here on this slide. Moving from left to right, the first backflow preventer is sometimes seen on combination ovens. The two in the center you would see on units on ice machines, coffee machines, juice machines. The last unit to your right is typically seen on carbonators for the potable water service line.

Pressure vacuum breaker assembly, or PVB. These are utilized for continuous pressure situations, for a health hazard, and protect against backsiphonage only. Reduced pressure principal assembly. These are utilized in continuous pressure situations for a health hazard, and protect against backpressure and backsiphonage.

Here we have an example of reduced pressure assembly backflow prevention device. Inlet side, outlet side, an arrow indicating flow through the unit, intermediate atmospheric vent, and on this unit, we should have four test cocks to test the unit; do the annual testing on the unit. One of these is broken off. If this had occurred on the vessel, the entire unit would have to be replaced, or the test cock. As we turn the unit over, we reorient to inlet and outlet. We have two check valves-- one here, one here-- and a check line on the intermediate atmospheric vent.

Testable devices. All testable devices on board the vessel require annual testing. A specific test kid is required to do this testing, and pressure differentials must be recorded. These records must be kept for a minimum of one year.

This is a picture of an RP installed on a potable water line with a deck sink below. What is important to remember here is the distance between the intermediate atmospheric vent on the RP and the deck sink must be two times the diameter of the discharge from the RP.

Comprehensive cross-connection control program. This is a listing of all cross-connections in the potable water system aboard the vessel. Comprehensive cross-connection control program. The program should list all the connections on the vessel where potable water is connected to any other source, the location of that cross-connection, the type of protection provided, for example non-mechanical, air gap, or mechanical device, as we discussed earlier, the inspection record for the devices, and then any testing records for units such as RPs.

Pollutant. Pollutant does not cause a health hazard, but adversely affects the aesthetic quality of the water. For example, a coffee machine on the vessel at the beverage station, if it's backflowed into the potable water system, would not cause an adverse health effect, but would severely affect the aesthetics of the water.

Contaminant. Contaminants create a health hazard to the public through poisoning or spread of disease. For example, a water line connected to an acid tank or a chlorine tank in the potable water system for introduction of these chemicals for treatment backflowing into the system would cause a severe health hazard.

Degree of hazard versus protection. A pollutant, coffee or detergent, require less level of protection than a contaminant such as body fluids, sewage, or toxic chemicals.

Sewage requires the highest degree of protection, an air gap. When we discuss sewage on the vessels, we are talking about blackwater, not graywater. Sewage, as stated earlier, requires an air gap only, because this is a physical separation and cannot fail.

Class exercise.
We will now pause from the lecture portion of this presentation and work on a class exercise. You will be provided with four exercises, schematics. You can use these schematics or feel free to develop your own. On the schematics we are presenting here, you will have to know: are the colors on the lines correct, is protection needed, is the protection provided adequate, what would you do to protect the potable water supply, and change the color on lines if needed at the end of the exercise.

Selecting appropriate devices. When selecting appropriate devices, you need to determine the degree of hazard, whether it is a backpressure or backsiphonage situation, whether you have continuous or noncontinuous pressure, what are the device installation requirements per the manufacturer, and are there other device special consideration per the manufacturer? For example, is this a hot water situation versus a cold water situation, or are you adding chemicals into the line that may need extra protection?

WOMAN: We will now review the lube oil schematic. This schematic depicts both deck zero engine room and deck one engineer change room. For this schematic, you will need a copy of the Watts catalogue. Beginning at the bottom of the schematic, we can see that a sink and two laundry machines are connected to the potable water supply. If we begin at the top water supply, we can see the hot water line is not striped blue. There is, however, a backflow protection device installed on this water line. When we review the Watts catalogue, we can see that 800M4QT would not be appropriate for this connection because there are temperature limitations for this device. Moving on to the potable water line supplying the laundry machines and the sink, we can see that the potable water line is painted or striped blue. However, there is no backflow protection device provided on this potable water line. To correct this, we can move the backflow protection device installed on the hot water line to the cold water line and find a suitable replacement for backflow protection on the hot water line that is for both continuous pressure and high temperature applications. Moving on to the deck zero engine room, we can see that we have both hot water and cold water supplying a high pressure wash. Neither of these potable water lines have backflow protection. However, the cold water line is painted or striped blue. To correct this, we would need to paint or stripe the hot water line blue and provide backflow protection on both the hot water line and the cold water line. This application is both continuous pressure and is under backpressure and backsiphonage. The only device that would be acceptable on a cruise vessel under these circumstances would be a reduced pressure backflow protection assembly, one installed on the hot water line and one installed on the cold water line. If we continue to follow the potable water line, we can see that it is connected to three lube oil separators. There is no backflow protection provided on these devices. There is a simple way to correct this. After installing the reduced pressure device on the potable water line, we can pull the potable water line to supply the lube oil separators downstream of that RP. That would both protect the high pressure wash and the lube oil separators. Now we move on, and we can see the potable water line supplies both the eye wash station and the emergency shower. There is no backflow protection requirements for these two connections. If we, however, pull the water line supplying the lube oil separator from before the RP, we may have problems with backflow protection for the eye wash and the emergency shower.

We will now review the schematics for the mineralizer. Let's review the components on the schematic. We start at the bottom, we can see we have a graywater tank. Proceeding on, we can see we have evaporator one, evaporator two, evap treatment tank. We also have a mineralizer. Starting from the evaporators, we have two evaporators, evaporator one and two, which make potable water. These water lines go to the mineralizer. They are both painted or striped blue. From the mineralizer, we can see that we have a backwash drain line directed to a deck sink. This deck sink is then directed to a graywater tank below. There is no air gap on the drain line for the backwash from the mineralizer. To correct this, we can cut this line so that there is a distance of two pipe diameters between the discharge line of the drain line and the overflow of the deck sink. This would be considered an air gap. We will disregard the line going to the chlorine dosing station and return back to the evaporators. Evaporator one only makes potable water. We will disregard evaporator one for the rest of the review. We will now continue to evaporator number two. Evaporator number two makes both potable water and water for the technical water system. The line leaving the evaporator proceeding to the technical water system passes through a reduced pressure backflow assembly. This prevents technical water from flowing back and potentially contaminating evaporator two or backflowing and proceeding on to the potable water system. This is the appropriate backflow protection device to be installed at this location. Additionally, if a reduced pressure backflow protection assembly is not selected, an air gap is another viable alternative to protect the potable water system from backflow of technical water. Let's proceed on now to this vap treat tank. This vap treat tank is used where water is added, and chemicals, which is then supplied back to the evaporators to allow the evaporators to function correctly. The problem we have here is that the line going back to the vap treat tank is coming from the technical water side of the reduced pressure assembly. The way to correct this would be to take the line from the potable water side of the reduced pressure backflow protection assembly.

We will now review the chemical dosing tank schematic. If we take a look at the bottom of the page, we can see that we have a reduced pressure assembly installed somewhere on the schematic. We also have an eye wash station. The dash line surrounding the schematic is meant to indicate bulkheads. Starting from the center left hand side, we can see we have a potable water line coming into this room which is painted or striped blue. However, once that line passes the bulkhead, there is no other indication that this is a potable water line. This should be corrected. We will discuss how to correct this once we've identified what backflow protection we are going to use.

As we follow the line across, we can see that an eye wash station comes off the line before the reduced pressure backflow protection device. This is the correct installation of this potable water line. No backflow protection is required on eye wash stations unless they have a submerged inlet, and this one does not. As we pass through the reduced pressure backflow protection device, we can see that water supplies both an acid tank and a chlorine tank. This reduced pressure backflow protection device would be proper protection, and perhaps overprotection considering the application. If we follow the line up, we can see that we have a water fountain supplied from this water line, and a spray hose. The spray hose is protected by this reduced pressure backflow protection device. However, there is a concern for this water fountain. While the potable water supply is protected by this reduced pressure backflow protection device, we can still have backflow. And this backflow, while it would not go into the potable water supply, may end up at this water fountain. This is not the correct installation of a water line for a water fountain in this space. The way to correct this, which is very simple, is to pull the water line for the water fountain prior to the reduced pressure backflow protection assembly. Again, we would pull the water line from this location and direct it to the water fountain. And once we've decided to do that, we would need to paint this potable water line blue up to and ending at the reduced pressure backflow protection assembly.

We will now review the sewage treatment tank schematics. In this space, we are in sewage treatment room, deck zero. Beginning on the bottom right hand corner of the page, we can see that somewhere we have installed a Watt series eight backflow protection device. Additionally we have installed a double check valve assembly. The dash line is meant to convey the bulkhead. Proceeding to the lower left-hand corner, we can see that we have a potable water line that is painted or striped blue going from one room to another. As this line passes the bulkhead, we can see that it is no longer painted or striped blue. This is incorrect. Additionally, we have a double check valve assembly as the backflow protection device for both the crew whirlpool compensation tank and the cleaning tank. Double check valve assemblies are not acceptable for any cruise vessel within the Vessel Sanitation Program. We will proceed on before we discuss how to correct this. The water line continues on and serves a hose connection. This hose connection does not have a valve downstream of the device, and if you review the Watts catalogue, you will see that this backflow protection device is appropriate for this application. However, we can see that we have a blackwater tank or a sewage tank in this room. We must ask a question relating to how this hose is used. If this hose is used in any shape or form to clean out or rinse out this tank, this Watts series eight backflow protection device would not be acceptable. The only acceptable backflow protection for sewage or blackwater is an air gap. Let's go back to this double check valve assembly and decide what we can do to correct this. If we remove this device and provide an air gap at this cleaning tank and an air gap at this crew whirlpool compensation tank, we will have corrected this deficiency. We would, however, have to continue to stripe or paint these potable water lines blue.

CAPTAIN CAGLE: This now concludes our session on cross-connection control. For further references and resources, you may wish to visit CDC at www.cdc.gov or the Food and Drug Administration at www.fda.gov, the Environmental Protection Agency at www.epa.gov, or the University of Southern California at www.usc.edu.