Cleaning and Disinfection of Premises

After a natural disaster or an infectious disease has occurred, the premises will need to be cleaned and disinfected as part of the recovery plan. Cleaning and disinfection should be done before the animals are reintroduced into the facility. Depending on the nature of the disaster or the type of enclosure in which the infectious disease occurred, such as a broiler house, layer house, milking parlor, exhibit enclosure, or barn, special cleaning and disinfection procedures may be required. An important point to remember is that disinfectants will not work if the surface to be disinfected is not clean before applying the disinfectant! It is almost impossible to disinfect dirt! In other words, cleaning and disinfection are two entirely separate procedures. The facility must be cleaned first. After the facility is cleaned, then it can be disinfected.

Cleaning Techniques

Cleaning the premises refers to the physical removal of organic matter, thus exposing the pathogens to the killing power of the disinfectant. Organic materials such as soil, plant debris (like straw or hay), milk, blood, pus, and manure inactivate some disinfectants or protect microorganisms from the disinfectant's active ingredients. Chlorine-based disinfectants are especially problematic in this regard. The active ingredient in bleach, chlorine, is relatively quickly inactivated by organic debris such as manure, and even milk, at the concentrations used for disinfecting cleaned surfaces. This is why cleaning to first remove organic debris and dirt is so important.

The cleaning procedure may involve two steps, a dry cleaning followed by a wet cleaning. The process of dry cleaning removes the organic material before the wet cleaning occurs. With the dry cleaning residual dirt, debris, stains, and organic matter, which might neutralize the disinfectant, must be removed first. Bedding, feed, and manure and any carcasses must be removed. Vermin such as rodents, insects, or any other animal need to be trapped and removed from the facility. The facility should be swept out. Loose dirt, litter, broken eggs, cobwebs, dropped feathers, dried milk, trash, debris

and any other material must be swept out or removed from the facility's interior. The sills and floor should be hand scraped if necessary to remove any caked-on manure, food, or debris. Scrape, scrub, and clean all permanently attached equipment such as waterers, feeders, etc. Removable equipment such as brooder guards, jugs, hand feeders, mangers, grooming equipment, or anything not attached should be taken outside to allow thorough cleaning and subsequent disinfection. All floors, light fixtures, fan blades, and louvers must be cleaned. Burned out light bulbs should be replaced and other bulbs should be cleaned. Lots of elbow grease may be required.

Wet cleaning involves the use of water and usually a soap or detergent. Soaps and detergents are good cleaning agents. They help penetrate and break up stubborn materials and are mildly germicidal, but they are not suitable for use as disinfectants. The soap or detergent used must be compatible with the disinfectant that will be used in the subsequent disinfection process.

There are four basic steps to the wet cleaning process: soaking, washing, rinsing, and drying. With a wet cleaning allow a soaking time to loosen debris so it can easily be removed with a brush or sprayer. Steam and high-pressure washers are very useful for cleaning porous surfaces during wet cleaning. Hot water of at least 200ºF should be used for wet cleaning. Hot water is far more effective than cold water at killing bacteria. Hot water can also be used in pressure sprayers. A detergent may be added to the sprayer to increase its effectiveness. All spray should be applied at a minimum of 200 psi (pounds per square inch) for good penetration. However, this amount of pressure could blow holes in aging materials or a thin cover. Care should be taken not to get the spray into electrical motors. Duct tape can be used to cover the slots in the motor housing. A systematic approach to spraying should be used, such as starting at the back of the facility and working toward the front, spraying the ceiling first, then the walls, and finally the floor. A thorough rinsing with clean water afterwards removes the detergent and any lingering organic debris and pathogenic organisms that could interfere with the effectiveness of the disinfectant to be used. Rinsing will also decrease the possibility of harm to the animals by accidental absorption of any residual detergent or soap.

The final step of cleaning is letting the wet areas dry quickly and thoroughly. If the facility is not dried properly the excess moisture will result in the multiplication of bacteria to even higher levels than before the cleaning! Thus, improper cleaning can do more harm than good. A proper cleaning should remove more than 90% of the pathogens. Once the facility has been properly cleaned and dried thoroughly, then the disinfection procedure can begin.

Disinfection

Disinfectants are chemical agents that kill pathogens on contact. Disinfection is the destruction of all vegetative forms of microorganisms, but the spores may not be destroyed. There are some basic principles to consider for disinfection. An important point to remember is "hard" water can neutralize the activity of some disinfectants. Also, some disinfectant solutions may only be active for a few days after mixing or preparing. Failure to make a fresh solution of disinfectant after it has been prepared longer than a few days, or after it has become visibly contaminated by organic material like manure, may result in using a product that will no longer be effective. Even worse, it may generate a false sense of security to the disinfection process. Sufficient concentration and contact time may overcome some of these problems with certain classes of disinfectants, but often increasing the concentration or contact time makes use of the product impractical, expensive, caustic, or dangerous to the users or to the animals.

Disinfectants also vary considerably in their activity against the assorted bacteria, viruses, fungi, and protozoa about which livestock and poultry producers may be concerned. As an example, plain vinegar (4% acetic acid) will readily kill the Foot-and-mouth Disease virus, but it will not kill the bacterium *Mycobacterium paratuberculosis*, the causative agent of Johne's disease. The product label should be checked for the expiration date. Use of an expired disinfectant may not insure effectiveness of the disinfection procedure.

Many widely used disinfectants are not active against bacterial spores, the environmentally resilient life form of the bacteria that cause tetanus, blackleg, botulism,

and anthrax. Formaldehyde is effective against most spores, but it is not really a practical disinfectant and is now considered a potential carcinogen or cancer-causing compound.

It is important to select a disinfectant that will be active against a wide spectrum of pathogenic organisms under the conditions in which it will generally be used. These conditions include hard water, contamination with organic debris, and the potential for toxicity or damage to environmental surfaces, skin, and clothing. It is also important to keep solutions clean and freshly made as per the manufacturer's directions. OSHA regulations concerning the disinfectant must also be considered.

All disinfectants, whether they are sprays, foams, aerosols or fumigants, work best at temperatures above 65ºF. Temperatures for chlorine- and iodine-based disinfectants should not exceed 110ºF.

Disinfectants must have sufficient contact time with the surfaces to which they are applied in order to allow them to kill the pathogens concerned. Few disinfectants kill instantaneously. The amount of contact time needed will vary with the product used and the pathogen. A quick splash of a dirty boot into a footbath will not accomplish anything except to give a false sense of security. Usually 20-30 minutes is a sufficient contact time for most disinfectants.

Another important point to remember is that disinfectants are not to be applied to animals directly, unless labeled for such use, and the label of the product must be followed closely to make sure there are no warnings against using them around feeders and in animal quarters. A general recommendation is to thoroughly rinse both the cleaning agents and the disinfectants off and dry the surfaces after the appropriate amount of contact time with the disinfectant if animals will have contact with the disinfected surfaces. It is best to have a down time of 2-4 weeks after drying of the disinfectant if possible before reintroduction of any animals. This will aid in the prevention of accidental absorption of residues, to limit contact irritants, and insure that odors have dissipated that could harm the respiratory system of a cage or stall's occupant.

Rotating low pH with high pH compatible disinfectants has shown to be more effective than continuous use of the same disinfectant to reduce the possibility of microbial resistance. Microbes can acquire resistance to disinfectants, just as they can to antibiotics. Label directions should be strictly followed, and different classes of disinfectants should not be mixed. Adverse, even deadly, chemical reactions may occur.

Table 1 on the next page is a chart of disinfectants that has recently been made available by the USDA for field use in a Foot-and-mouth Disease outbreak. As mentioned in Table 1, common household bleach can be an effective disinfectant against the FMD virus, but the recommended concentration (3% sodium hypochlorite) is 60% of full strength as it comes from the bottle. At this strength damage would occur to clothing, shoes, and rubber goods and would be mildly corrosive to steel surfaces. It can be used on an infected premise for FMD, but probably would not be a safe choice as a general-purpose disinfectant for equipment and footbaths at this strength. Vinegar will also kill the Foot-and-mouth Disease virus, but it would also not be a good choice for general use because of its lack of effectiveness against many other important pathogens. Lye is too caustic for general use as a disinfectant.

Table 1-Chart of Disinfectants for Foot-and-Mouth Disease

Product	Dilution	Mixing Instructions	Notes
5.25% Sodium Hypochlorite (NaOCI) **(Household bleach)**	3%	Add 3 gallons of chlorine bleach to 2 gallons of water; mix thoroughly.	This concentration can damage clothes, shoes, rubber goods, and is mildly corrosive to steel surfaces.
Acetic acid*	4-5%	Add 6.5 ounces of glacial acetic acid to 1 gallon of water; mix thoroughly.	Vinegar is a 4% solution of acetic acid. Not good for general premises disinfection
Potassium Peroxymonosulfate and Sodium Chloride (i.e. Virkon-S)	1%	Follow label instructions	Virkon-S
Sodium Carbonate **(Soda ash)***	4%	Add 5.33 ounces of sodium carbonate to 1 gallon of hot water (or 1 pound to 3 gallons of hot water); mix thoroughly	The solution is mildly caustic but can dull paint and varnished surfaces.
Sodium Hydroxide **(NaOH)** **(Lye)***	2%	Add 1/3 cup of NaOH pellets (2.7 ounces of the lye) to 1 gallon of cold water; mix thoroughly	This solution is highly caustic. Use protective rubber clothing, gloves and safety glasses. Too caustic for general use. **WARNING:** Always add the lye to the water. Never pour the water over the lye.

* Section 18 application submitted and EPA approval is pending.
** From National Emergency Response to a Highly Contagious Animal Disease, Executive Summary, March 30, 2001. http://www.aphis.usda.gov/oa/pubs/fco412.pdf

Table 2 is a chart of disinfectants that has been recommended by the Office of International Epizootics (OIE) for use in poultry houses and for hatchery equipment and washing eggs.

Table 2-Properties and Uses of Disinfectants for Poultry

Properties	Chlorine	Iodine	Phenol	Quats	Formaldehyde
Bactericidal	+	+	+	+	+
Bacteriostatic	-	-	+	+	+
Fungicidal	-	+	+	±	+
Virucidal	±	+	+	±	+
Toxicity	+	-	+	-	+
Activity with organic matter*	++++	++	+	+++	+
Use area					
Hatchery equipment	+	+	+	+	±
Water equipment	+	+	-	+	-
Personnel	+	+	-	+	-
Egg washing	+	-	-	+	+
Floor	-	-	+	+	+
Foot baths	-	-	+	+	-
Rooms	±	+	±	+	+

Quats	=	Quaternary ammonium compounds
*	=	Number of + indicates degree of affinity for organic material and the corresponding loss of disinfecting action
+	=	Positive property
-	=	Negative property
±	=	Limited activity for specific property

From Hygiene and Disease Security Procedures in Poultry Breeding Flocks and Hatcheries, OIE, Appendix 3.4.1. June 9, 2004.
http://www.oie.int/eng/normes/mcode/en_chapitre_3.4.1.htm

On most farms, disinfectants will be used in footbaths, for disinfecting equipment, and to disinfect livestock and poultry premises. The disinfection should occur as soon as possible after the cleaning procedures. The disinfectant needs to be applied to all cleaned surfaces, and allowed to dry completely. It is optional but recommended to reapply the disinfectant and allow it to dry a second time. All cleaning and disinfecting equipment such as rakes, shovels, scrapers, brushes, trucks, manure spreaders, bucket loaders and

spray/disinfection devices also should be cleaned and disinfected after use and stored in a secure location. Bed the areas with fresh materials and clean, disinfect, rinse, and dry all water and feeding equipment before refilling them.

Usually one gallon of diluted disinfectant is ordinarily applied to approximately 100-150 square feet of surface area. A formula for estimating the total amount of disinfectant solution needed has been developed. Determine the total surface area of the floor, ceiling and walls. Then add 30% to this area to allow for cage surfaces.

Types of Disinfectants

The most commonly used disinfectants fall into the following classes.

Quaternary ammonium. The older quaternary ammonium compounds (Roccal® DT) are good for some situations and relatively clean surfaces. Quats, as they are commonly called, are often used to clean incubators and hatching trays. They are effective against gram-positive and gram-negative bacteria and somewhat effective against fungi and viruses, but are not particularly effective against Foot-and-mouth Disease or *Mycobacterium paratuberculosis*, the cause of Johne's disease. They have markedly decreased activity in the presence of organic material and are not sporocidal. They have good residual activity. Some of the newer quaternary ammonium preparations have improved activity. Compounds in this class usually have some detergent action; however, they are usually inactivated when in contact with many soaps or soap residues. When used as recommended quaternary ammonium products are non-toxic, but some of the more potent ones can be corrosive and dangerous if they contaminate the eyes or the skin. These compounds are widely used in commercial hatcheries. Other examples besides Roccal include Hi-Lethol®, Germex®, and Zephiran®.

Phenol-based compounds. These compounds are coal-tar derivatives and often have a strong pine-tar odor. They generally turn milky when added to water and have good activity in hard water and in the presence of some organic material. They are considered active against many bacteria, viruses, and fungi, including the bacteria that cause tuberculosis and Johne's disease, but are not sporocidal. They are not especially effective

against the FMD virus; however, they are good all-purpose disinfectants for farm use. Some examples of this class of disinfectants include One Stroke Environ®, Osyl®, and Amphyl®. Lysol®, Pine-Sol®, and Tek-Trol® are also phenol-based products. Cats are extremely sensitive to phenol compounds so these products should be avoided when disinfecting feline quarters.

Coal tar distillates (cresol and cresylic acid): Coal tar distillates are similar to phenols and are effective against most bacteria and viruses but are not sporocidal. They are corrosive, staining, and toxic at high concentrations and for this reason are not suited for use around eggs or chicks because of the noxious and toxic gasses produced. They do have excellent residual activity but leave a very strong odor. They are highly efficient in the presence of organic matter. They are not affected by heat. Because of their potential toxicity they are not normally used in incubators but for disinfecting bird houses and pens.

Hypochlorites. Chlorine compounds are good disinfectants on clean surfaces and have a broad spectrum of activity. They are effective against bacteria and many viruses, especially Parvovirus, but are not sporocidal. They are often used as dairy sanitizers and generally are more active in warm water. They can be somewhat irritating and can be harmful to clothing, rubber goods, and some metals. Chlorine based compounds must be totally rinsed from any flooring or surface as animals that walk in bleach may suffer footpad burns. Some of the newer chlorine-based disinfectants are complex molecules that are less irritating and more effective than older ones such as bleach (Clorox) and Halazone®. Hypochlorites are not affected by the hardness of the water and are inexpensive. Chlorine-based disinfectants are generally compatible with soaps but should never be mixed with acids. Their activity is strongly reduced by the presence of organic matter and by the presence of ammonia or amino compounds. Many chlorine solutions are unstable and need to be frequently replaced; label directions should be strictly followed.

Iodophors. Iodine compounds have been used as antiseptics and disinfectants for many years. The iodophors are combinations of iodine and a solubilizing agent that makes them

water-soluble, allowing the slow release of free iodine. They are good disinfectants, but, like hypochlorites, are not as effective in the presence of organic material. Iodophors are generally less toxic than other disinfectants but can stain clothes and other surfaces. They work well for sanitizing food and water dishes, but may be too expensive for general use. They are inactivated in the presence of some metals and by sunlight. They are effective in both hard and soft water and over a wide pH range. They are effective in both cold and warm water and have a broad bactericidal and fungicidal action but are not sporocidal. They should not be mixed with quaternary ammonium disinfectants, as they will be inactivated. Some examples of this class are Betadine® and Weladol®.

Lye (Caustic soda, sodium hydroxide, NaOH): Lye has been extensively used as a cleaning and disinfecting solution, especially on premises exposed to an infectious disease. For general disinfection it is most active in hot or boiling water. Lye will not harm bare wood, earthenware or metals except aluminum, but it is corrosive to painted or varnished surfaces, textiles, and aluminum. It has excellent virucidal activity. However, it has no residual effect and is caustic. Personal protective equipment such as rubber clothing, gloves, and footwear should be worn. Eye and face protection is needed to protect against splashing.

Lime (Quicklime, CaO): Lime is produced by burning limestone. If water is added to quicklime, slaked lime is produced. If lime is exposed to the air, air-slaked lime is formed. Lime is strongly alkaline, corrosive, and has been used to spread over carcasses before they are buried to destroy infected animal tissue due to its caustic action. However, current thought is that the lime may actually destroy the putrefying bacteria and hamper bacterial degradation of the carcass if placed directly on the carcass, especially under wet conditions. Lime is not used as much as a disinfectant anymore because there are safer and more effective products on the market. Lime is caustic to organic matter and will destroy debris, including pathogenic microorganisms. A major disadvantage to its use it that it is extremely hazardous to work with, causing severe burns on surface contact and may be explosive if lumps of lime come into contact with water. Dust inhaled or exposed to the eyes can cause severe burning of the eyes and mucous membranes. Personal protective equipment must be worn when using lime as a

disinfectant. It will also burn the footpads of animals if left on the ground or floor, and can also cause the hoofs of hoofed animals to dry and crack.

Aldehydes (Formalin, formaldehyde, glutaraldehyde): Formalin is a 40% solution of formaldehyde gas in water. The standard disinfection solution is made by making a 10% solution, resulting in a 4% solution of formaldehyde gas in water. Formalin has been used to kill various bacteria, viruses, and fungi, including anthrax spores, and is effective against mycobacteria in vitro but is not as effective in the presence of organic material. Aldehydes have a slight residual activity. These products are often used as fumigants for poultry houses as long as the houses are empty because the fumes are toxic to birds if inhaled or ingested. They are relatively inexpensive but are corrosive and also deaden odor perception. Aldehydes are considered sterilants and are also carcinogenic, which limits their use unless personal protective equipment is used. An example of a formaldehyde product is Wavicide®.

Chlorhexidine (Nolvasan-S): Nolvasan®. has been extensively used as a virucide, with activity against rabies virus. It is used to disinfect inanimate objects following thorough cleansing and has been used as a sanitizer for milking equipment. It is not particularly effective against gram-positive bacteria or *Pseudomonas*. The label directions recommend 1 ounce per gallon of water. It is only minimally toxic with minor eye irritation but the product has been used on mucous membranes with safety.

Newer compounds. New disinfectants are being introduced regularly. Some of these are oxidizing agents. Virkon SR® is a peroxygen molecule/organic acid/surfactant combination (surfactants reduce surface tension to help water-based compounds penetrate). It appears to have a wide spectrum of activity against many kinds of pathogens (including the FMD virus) and is relatively stable in the presence of some organic material. Its pH is 2.6 when mixed as directed, but is labeled as nonirritating to skin. Virkon SR® is useful on many kinds of equipment, including saddles, brushes, buckets, etc. Another compound, based on peroxyacetic acid, is Oxy-Sept 333R®. It has received EPA approval for use against FMD virus and is reported to be active against a broad spectrum of microorganisms.

In the event of a foreign animal disease outbreak, such as FMD, the type of disinfectant and procedures to be used in the cleaning and disinfection of infected farms and for routine prevention activities will be selected by regulatory officials. For routine use in biosecurity programs at the farm level, producers should consider the major risks they are concerned about, consider the type of surfaces to be disinfected, the conditions under which the disinfectant will be used, and then select a disinfectant that best suits their needs. Information about activity in hard water or in the presence of organic debris, contact time needed, what pathogens are reliably killed, human use and environmental concerns, and other details are usually on the label or can be obtained from the company. Web sites may provide good sources of information about individual products. Above all, producers should remember that disinfection is just one aspect of their biosecurity program.

Special Cleaning and Disinfection Procedures

Concrete or Wooden Construction: All surfaces must first be thoroughly cleaned of all fecal material and organic debris. Any bedding must be burned or buried. If the disease was reportable the directions of the regulatory agent in charge should be followed. The walls and floors should be scrubbed with a hot detergent cleanser solution. A steam cleaner may help, but it does not take the place of mechanical scrubbing. If there are no painted surfaces within the enclosure complete the cleaning with the application of a hot lye solution. If painted surfaces are present use of One Stroke Environ®, an O-phenylphenol disinfectant, is recommended. Allow the enclosure to remain vacant for 48 hours and rinse all surfaces of disinfectants before reintroducing any animals.

Enclosures with dirt floors: If soil is kept over a concrete base all of the soil should be removed and heat-treated or soaked in One Stroke Environ® solution. The soil should then be discarded and replaced with new uncontaminated soil. The removed soil should be soaked down with a disinfectant and hauled away, burned or composted, depending on the disease agent.

If there is no concrete floor under the soil, all organic debris must be removed first. Remove the top 10 cm (4 inches) of soil and treat as previously described. The soil that remains should be liberally soaked with a solution of O-phenylphenol (One Stroke Environ®) or formalin or Virkon S®. Quicklime may also be spread over the surface but care must be taken that no animals come into contact with it. For cleanup following a tuberculosis outbreak, use O-phenylphenol only. Allow the disinfectant to dry in place then replace the top 10 cm of soil with new uncontaminated soil.

All fences, walls, mangers, feeders, waterers, shrubs and trees within an enclosure must be cleaned and disinfected. Play objects, exercise objects, chains, and ropes used within the enclosure must be removed, cleaned, and disinfected or discarded if it cannot be properly cleaned. Attention must be paid to every crack, crevice, ledge, and site that may be reached with tongue or limb.

Viral disinfection: Sunlight is an excellent virucide. Ultraviolet fluorescent lamps may be of value in reducing the viral infections in enclosed quarters. Chlorine, formaldehyde, and quaternary ammonium compounds are also good virucides.

Horse Barns and Stalls: The most common pathogens in horse barns are clostridial organisms, *Salmonella*, *Streptococcus*, and *Rhodococcus*. Viral infections of concern for horses include rotavirus and influenza. It is very difficult to sanitize paddocks and kill equine pathogens. Chemical disinfectants will not only kill pathogens, but also normal flora, which help to keep the soil healthy. Feces should be removed from dirt paddocks. Dragging during dry times to help dry out manure, reseeding bare spots, and not allowing overgrazing will reduce the potential spread of equine pathogens. Checking the soil pH will indicate whether lime may need to be added. If the pH is too low lime will improve the fertility of the pasture and help reduce pathogenic organisms.

To disinfect the stalls or paddock organic matter needs to be removed. The bedding needs to be removed, and the walls and fencing need to be swept or scrubbed off. A pressure washer should then be used with a strong detergent to wash all surfaces. Some areas that

are heavily stained may require hand scrubbing. After all surfaces are cleaned and rinsed, as much water or moisture should be removed as possible before the disinfection process is begun. Phenolic compounds such as Tek Trol® or One Stroke Environ® can be used in a sprayer and sprayed on all surfaces including the floor and allowed to dry (do not rinse). In an outbreak of an infectious disease repeat the spraying and drying of the disinfectant. Buckets, and any portable feeding or drinking vessels should be scrubbed, disinfected, and rinsed. Anything from which the horse will eat or drink should be rinsed of the disinfectant once it has dried.

Broiler Poultry Houses: Because of the extent of the broiler industry in the State of Georgia special consideration should be given to the cleaning and disinfection of these facilities, especially after a disease outbreak or flooding. The first step in cleaning and disinfection of a poultry house is to treat the poultry house to eliminate litter beetles and flies. Some producers treat the house after birds are removed from the house before the insects have a chance to move in. Others prefer to wait until the litter has been removed and apply the approved pesticide as part of the washdown procedure. If a residual soil treatment is used, it should be applied to the dirt floors after the completion of all cleaning and disinfecting and before fresh litter is put down. Whatever litter beetle pesticide is used the label directions of the product must be followed exactly.

If not already in place rodent control should also be instituted at this time. The best method to control rodents is to close all access routes into buildings. Cats, traps, and rodenticides have all been used to control rats and mice in poultry houses. If rodenticides are used make sure all birds are out of the house, and precautions should be taken to insure no pets or other animals are allowed into the house or come in contact with the poison or poisoned rodents as they may also be poisoned. Follow all manufacturers' directions.

Next, remove all moveable equipment from the house. Clean and then disinfect this equipment and leave it outside to dry in the sun while completing the rest of the cleaning and disinfection. The sunlight act as a virucide.

All litter/manure must then be removed from the house. If the litter/manure is stored on the premises, it should be moved as far away from the houses as possible, at least a minimum of 100 yards. The litter/manure should be covered with plastic if it is to be stored for more than a few days. The litter should be composted if possible.

After the litter has been removed, the dust and cobwebs should be removed from the walls, ceilings, curtains, fan blades, louvers, equipment, etc. After removing the litter and any remaining dust and debris, the house should be thoroughly washed. The washing procedure is best performed using a high-pressure spray washer. (Note that high-pressure washers can damage ceilings and curtains.) Add detergent to the water to increase the water's cleaning action. Make sure the detergent used is compatible with the compound subsequently used for disinfection. The water temperature in the sprayer should be at least 200ºF to aid in the killing of any microbes.

Fan motors, switch boxes, outlets and other electrical equipment should be covered before washing down the house to prevent burn-out of equipment and possible electric shock and fires. Clean these types of equipment with a blower, dry brush, or rag before covering them. Start at the top of the house and work down. It is crucial to remove all dust, dirt, litter, and manure from the house. Ledges, braces, air intakes, and all other places where dust, dirt, feathers, and waste accumulate must be cleaned. Most disinfectants are less effective if used in the presence of organic material. The dirt and fecal material bind the disinfectant that would otherwise be available to kill the microorganisms that cause disease. All disinfectants work best on a clean surface.

Fumigants have been used in the past to disinfect poultry houses. Today, there is some concern over the safety of many of these products as some, such as formalin, are quite poisonous or carcinogenic. Great care must be used when using fumigants. Label directions must be closely followed. Only products that are approved for poultry house disinfection should be used. Fumigation is most effective when the house can be closed airtight.

Disinfection of the house comes after cleaning has been accomplished. There are numerous types of disinfectants that can be effective when used properly. The most accepted types of disinfectants for poultry houses are synthetic phenols, coal tar distillates, and quaternary ammonia compounds. These compounds are best suited for use because they are not as susceptible to deactivation by organic material, and they are relatively non-corrosive to equipment. Even within these families of disinfectants, some are more effective than others when organic debris is present. Whatever disinfectant is used the label directions must be read and followed exactly, and the product used in the manner for which it is intended. In most cases, the best way to apply a disinfectant is by spraying or foaming it on with a medium pressure sprayer. Steam cleaning (at 285ºF) with water alone is also a very effective way to disinfect if the necessary equipment is present. After disinfecting, allow the house to dry completely.

All feeders, hoppers, and feed bins must be thoroughly cleaned and disinfected. Scrape and scrub the feeding system to completely remove all the old feed. Also, remove the feed bin boot and clean out any remaining feed. Clean the bin with a high-pressure sprayer and then disinfect it with a 10% chlorine bleach solution. The boot can be left off until the bin is completely dry, but it must be reassembled before the first feed delivery arrives. Waterers must also be cleaned and disinfected. Water lines must be flushed out and any tanks, proportioners, medicators, etc., must also be cleaned and disinfected.

Fresh air and sunlight are excellent at reducing the numbers of microbes present. Let as much light and air into the house as possible during the down time. No wild birds or any other animals should be allowed to enter the house at any time, but especially after it has been disinfected. Wild birds and other animals can carry viruses and bacteria on their fur and feathers and recontaminate the house, negating the effects of cleaning and disinfecting.

In addition to cleaning and disinfecting the inside of the house, the immediate area around the exterior of the house must also be cleaned and disinfected. Keep vegetation surrounding the poultry structures mowed short. Disinfect 10 feet around the outside of

the buildings. Clean and disinfect entrances to the house. These areas must be as free of litter/manure and feathers as possible.

The following is a summary checklist for cleaning and disinfecting a broiler house:

- Treat the house for litter beetles, flies, and rodents
- Remove all removable equipment
- Clean and disinfect the removed equipment; and store in a sunny location.
- Sweep out all litter and manure from the house.
- Wash down the house completely from top to bottom.
- Cleanse and disinfect the watering system and the entire feeding system from the bins to the pans.
- Fumigate the house if necessary and follow the manufacturer's directions.
- Spray the entire house with a disinfectant approved for use in poultry houses.
- The house and equipment should be completely dry before returning the equipment to the house.
- Allow at least 12-14 days down time between flocks before introducing new birds back into the house. Bringing birds back into the house prematurely will increase the chance of cycling diseases from flock to flock.

Egg Hatchery House: Proper cleaning must be accomplished to remove the majority of microorganisms to which the eggs may be subjected. Cleaning applies to all areas of the hatchery including floors, walls, setters, hatchers, trays, chick processing equipment, air, and the personnel. Basically what was said about broiler houses will also apply here with noted exceptions for equipment.

All organic debris, dust, down, eggshells, droppings, tissue residues, etc. must be removed from the incubators and hatcher before each usage. This can be accomplished using a broom or vacuum. This is followed by thorough cleaning using warm water and appropriate cleaning agents. The detergent should be selected based on the type of disinfectant to be used. Wash the unit with a warm detergent solution. Rinse and dry. Then disinfect with a disinfectant solution. Quaternary ammonia compounds are the most

commonly used disinfectants for equipment such as incubators and hatching trays. They are relatively non-irritating, non-corrosive, of low toxicity, and have reasonable effectiveness in the presence of organic matter, depending on which "quat" is used. Since the incubator and its components should be clean and free of organic matter after the cleaning process, quats would make a good choice**.** When dry, turn the units on and bring to the appropriate temperature and humidity conditions prior to filling with eggs.

Fumigation is another tool for disease control in a hatchery and good to use when either the cleaning is poor, eggs are dirty, or machines are filled with eggs and it is difficult to empty and clean properly. The fumigation process can be hazardous to personnel if not conducted carefully. Formaldehyde and formalin are dangerous chemicals and are carcinogenic. State/federal (EPA, OSHA, FDA) authorities should be contacted before considering its use! Gas masks, personal protective clothing and equipment, and rescue plans are essential if formalin is to be used.

Poultry layer house: A complete cleaning and disinfection between each brood of pullets is highly recommended. Cage layer houses and equipment must be thoroughly cleaned and disinfected after each flock is removed from the premises and before a new flock is introduced. Again, the information for broiler houses will also apply here with notable exceptions to the type of equipment that is used.

Remove any manure from the house and place it as far away from the house as possible or a minimum of 100 yards. Cover dry manure and compost it if possible. Run-off from manure piles should not be allowed to contaminate the driveways or entrances to the poultry houses.

Sweep the house from top to bottom to remove cobwebs, feathers, etc. Institute vermin control. Floors, lighting fixtures, fan blades, air inlets, louvers, beams, ledges, walls, cages, and walkways must be thoroughly cleaned. Burned out light bulbs should be replaced and all other bulbs should be cleaned. Clean the facility by working from top to bottom.

A pressure sprayer is recommended for cleaning. A pressure of 750-2,000 psi is recommended but at this high pressure special care and personal protective garments are needed as this pressure can cut human skin. Care must be taken to follow the manufacturer's instructions for the use of the pressure sprayer. Use sprayer attachments and nozzles that permit washing of hard-to-reach areas. Wash the ceilings, walls, walkways, steps and cross-over platforms, egg rollers, all egg conveyors, cross belts, floors under conveyors, stairs to the pit, outside stairs, and concrete pit floors. Clean everything completely.

Special attention must be paid to clean and disinfect not only the top, but also the underneath sides of troughs and the surfaces of all chains and augers. Extreme care must be given to the egg elevator. Check for cleanliness from every angle possible, especially from the underside of the pit and from behind rollers. Remove all traces of egg breakage and spillage. If slats are used they should be removed and taken outside of the house for cleaning. They should be scraped of any manure, pressure washed to remove any residual material, disinfected, and left outside to dry in the sun. Any removable equipment should be taken outside, cleaned thoroughly, and then disinfected and allowed to dry in the sun.

Wash egg rooms, storage rooms, egg coolers, hallways, break, wash and restrooms. Manually clean any areas that have resisted prior cleaning.

Cover both sides of the curtains completely and thoroughly with spay to remove dirt, dust, and down. The curtains should be up and completely extended when cleaning and spraying. When dry the curtains may be dropped. The house should be allowed to air out completely.

After thoroughly cleaning the ceiling, curtains, wall, partitions, cages, feeders, waterers, and other equipment, they must all then be disinfected. Disinfection should occur within 24 hours of cleaning. The disinfectant should be applied at the rate recommended by the container label. Care should be taken not to get any water or spray into electric motors.

Use of pressure sprayers is advisable to help force the disinfectants into wood pores, cracks, and crevices that protect microorganisms. Spray pressures of 500-1,000 psi have been suggested. Work from back to front and from top to bottom.

Dirt floors are almost impossible to fully disinfect. In situations where dirt floors could not be concreted, disinfectant has been applied to the floor at the rate of one gallon diluted disinfectant per 10 square feet. Clorox has been used for this purpose.

Disinfect egg-handling equipment (elevators, egg belts, etc.) in accordance with recommendations provided by equipment and disinfectant manufacturers. The use of steam, vats of water at pasteurization temperatures, or soaking in disinfectant to disinfect egg belts has been suggested but not fully evaluated for effectiveness or harmful effects on the belt.

After the facility has been disinfected, it must be dried. Space heaters have been used to speed the drying process in cold or damp weather.

Cleaning and Disinfection of Vehicles/Equipment: Vehicles traveling between farms, livestock markets, and packing or rendering plants provide an excellent vector for spreading disease from one site to another. This fact is recognized as a main biosecurity threat. To prevent the spread of diseases during cleaning and disinfecting procedures vehicles involved in the process will also require cleaning and disinfection to reduce the risk of spreading diseases from one farm to another as well. Recommended procedures for cleaning and disinfecting vehicles involve the following principles:

Exterior of the vehicle:

- Ensure the crew involved in cleaning the vehicle is wearing clean and disinfected waterproof, protective clothing.
- Remove any deposits of mud, straw, or dirt from the wheels, wheel arches, mudguards, and exposed chassis of the vehicle.
- Remove all food, bedding, and dung from the trailer bed with brushes, scrapers, or shovels.

- Clean and disinfect the outside of the vehicle by starting at the top of the vehicle and working down each side, paying special attention to the wheel, wheel arches, and mudguards.
- Wash the tail gates and lifts thoroughly.
- Wash all vehicle equipment, tools, and the inside of the trailer.
- After washing is complete, a high-pressure rinse should follow to clean all surfaces with clean water and to check to make sure there is no muck or debris.

Disinfection of the vehicle cab:

- Take out all removable items from the cab and brush any debris or mud into a bucket or dustpan.
- Wash the floor of the cab, the floor mats, and vehicle pedals with a detergent such as Biosolve® allowing 10 minutes for the detergent to penetrate and loosen dirt.
- Use a clean cloth soaked in a disinfectant such as Virkon S® to disinfect the cab floor, mats, and foot pedals.
- All items removed from the cab must also be cleaned and disinfected in a similar manner.

Finishing:

- Park the vehicle on a slope to dry.
- Once the vehicle is removed from the wash area, rinse the concrete surface with a detergent, making sure no muck or debris remains.
- Disinfect overalls and boots with Virkon S®.

Wheel dips:

- Treat all vehicles as potentially contaminated, no matter how clean they seem to be when arriving.
- Set up a separate area for pick-up and delivery of livestock.
- Make all vehicles pass through a wheel dip and spray the wheel arches and underside of the vehicle with disinfectant.

- The wheel dip solution must be changed weekly or more frequently in cases of heavy soiling.
- All areas must be disinfected after usage.

Special Considerations after a Flood: If fields or farm buildings have been flooded, special precautions against flood-related accidents or diseases in poultry and livestock should be taken. Diseases such as pneumonia, foot rot, and Leptospirosis often occur after flooding due to the assemblage of large numbers of animals on wet ground where horn flies and houseflies may be abundant. Any evidence of disease should be promptly reported to a veterinarian or to the county extension office.

Provide clean unpolluted water to the animals, and inspect all feeds such as corn, wheat, and hay for water damage. Remove damaged grains and moldy hay, which could cause digestive upsets. Horses, sheep, poultry, swine, and cattle are affected most severely (in that order) by spoiled feed. Do not feed fodder that has been flooded, even though its appearance remains unchanged. Remove and do not feed any feed or forage that may have been damaged by chemicals or pesticides.

Standing water may have ruined some pastures. Lack of adequate forage could force animals to eat poisonous plants. Remove fallen wild cherry limbs from pastures to prevent livestock poisoning. Before restocking flooded pastures, remove debris, especially along fence lines and in corners. Livestock could be injured from pieces of barbed wire, sharp metal, and trash.

Clean out hog houses, barns, and chicken houses. Spray buildings with a good disinfectant before animals occupy them again. Stud wall cavities that have been under water may still have water in them, which will rot the wood if not allowed to drain and dry out. Air buildings thoroughly to dry them out to prevent the growth of molds. This is important not only for the health of the animals but also for any human workers in the facility. Remove debris from dairy barns. Remove soggy litter from poultry buildings. Let soil in earthen floors dry before putting in new litter, otherwise the new litter itself may become soaked. Disinfect those areas that animals can contact by spraying with

standard disinfectants. Phenolic disinfectants work well in the presence of organic compounds.

Scrub and disinfect walls, ceilings, floors, stanchions, and other equipment. Remove any loose wall sheeting and fiberglass insulation that has been under water. Wash flooded walls and floors similar to the way they would be washed between groups of animals or birds to remove as much organic material as possible. Consider using a pressure washer in well-ventilated areas.

Scrub the milk house and all of the equipment with detergent and hot water. Sanitize equipment, walls, ceilings, and floors with dairy sanitizer equipment. Clean and disinfect the milking parlor, dairy barn, and equipment before returning to normal use. Observe the cows for signs of mastitis, which is likely to occur if milking methods, time and equipment have been changed. Dispose of any dead animals promptly. Mosquitoes and other insects may be abundant after a flood. They not only annoy the animals but many will carry diseases. Spray the animals with an insect repellent recommended for the species.

Pump or drain floodwaters and manure from collection pits underneath swine houses into lagoons or land spread. Be aware that gases may have built up to unsafe levels inside houses with manure pits. Also, agitation or disturbance of concentrated manure in storage will release high concentrations of hydrogen sulfide gas, which will be unsafe for workers and animals inside buildings without adequate ventilation.

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