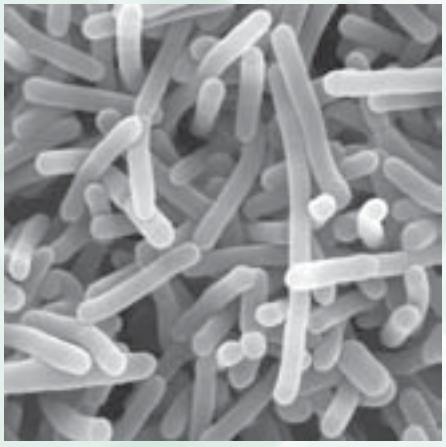
Control of ***Listeria monocytogenes*** *in*



Small Meat and Poultry Establishments

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Background

In recent years, serious outbreaks of listeriosis have occurred due to the presence of harmful bacteria in many types of meat and dairy products. Soft-ripened cheeses and underpasteurized milk have caused several cases, but recently, ready-to-eat (RTE) meat and poultry products have caused hundreds of illnesses and dozens of deaths.

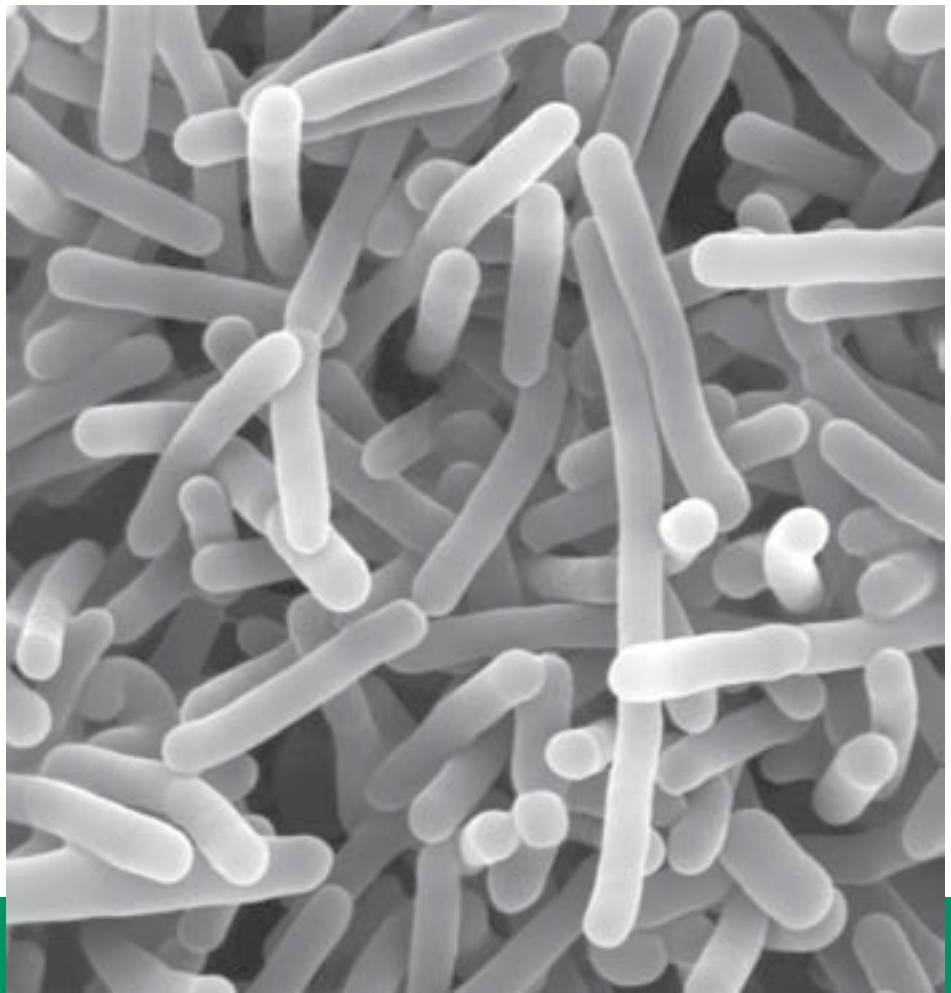
Steps must be taken to prevent contamination of meat products by *Listeria monocytogenes* at all levels of production. This is a difficult task, given the fact that *L. monocytogenes* is so widespread in the environment. It is not possible to completely eliminate *L. monocytogenes* from the meat-processing environment or to completely eliminate the potential for contamination in precooked or RTE products. This booklet is designed to provide guidelines for small processors on methods and practices for assessing and controlling opportunities for contamination of RTE products by *L. monocytogenes*.

Introduction

Listeriosis is a disease caused by the bacterium called *Listeria monocytogenes* (*L. monocytogenes*; see Figure 1). *L. monocytogenes* is found widely throughout the environment including soil, water, silage, and many other environmental sources. *L. monocytogenes* also survives in the digestive systems of at least 37 species of mammals, both domestic and wild, and up to 10 percent of humans may be intestinal carriers as well. It has been found in 17 species of birds and some species of fish and shellfish. Since *L. monocytogenes* is so widespread in the environment and livestock, it is not surprising that it is frequently found in vegetables and uncooked meat. *L. monocytogenes* is very hardy and can survive freezing, drying, high salinity, and, in some cases, heat.

L. monocytogenes is especially pathogenic to high-risk human populations, including newborns, pregnant women, the elderly, and people with weakened immune systems, such as persons immunocompromised by corticosteroids, anticancer drugs, graft-suppression therapy, and AIDS. Other conditions that may increase susceptibility to listeriosis are diabetes, cirrhosis, asthma, and ulcerative colitis. Healthy people are generally at a low risk of contracting *L. monocytogenes*-related illnesses; however, when heavily contaminated food is consumed, any person can be susceptible. Some research suggests that use of antacids also may increase the risk of contracting listeriosis.

Figure 1. Scanning electron micrograph of the bacterium *Listeria monocytogenes*. Magnification 3000X.



Although listeriosis is relatively uncommon, it is a potentially fatal disease and frequently results in spontaneous abortions in pregnant women. Even though the symptoms may be relatively mild in the mother, the illness may be transferred to the fetus, causing serious illness or fetal death. Symptoms of *L. monocytogenes* may include meningitis, encephalitis, septicemia, spontaneous abortion, stillbirth, and influenza-like symptoms. The onset of the disease can occur anywhere from a few days up to 6 weeks after ingestion of *L. monocytogenes* bacteria, with the symptoms lasting from a few days to several weeks. Listeriosis is clinically defined when the bacterium is isolated from blood, cerebrospinal fluid, or an otherwise normally sterile site (such as the placenta).

The latest figures from the Centers for Disease Control indicate that there may be as many as 2,500 cases of *L. monocytogenes* and as many as 495 deaths each year. The infectious dose has not been established at this time, but it is estimated that consuming as few as 1,000 organisms may be enough to cause illness in susceptible people.

Because *L. monocytogenes* is so widespread, it is important for food-processing operations to make every effort to prevent contamination by *L. monocytogenes* in raw, unprocessed foods and recontamination in precooked, RTE finished products. Due to foodborne illness associated with *L. monocytogenes* in meat and poultry products, the USDA has issued a zero-tolerance policy for the organism in RTE foods. As a result, a large number of recalls have occurred since 1998.

Today, a major food safety concern is that of recontamination of RTE or precooked foods after thermal processing. Examples of foods in which post-processing contamination has occurred and caused major listeriosis outbreaks include hot dogs and luncheon meats. In 1998, one of the largest outbreaks of *L. monocytogenes* in history occurred at a large manufacturer of hot dogs, resulting in 15 adult deaths, 6 stillbirths, and over 1 million pounds of product recalled.

Effective control of *L. monocytogenes* is challenging and requires intensive management and extensive resources. Even though the risk of contracting listeriosis is relatively low, the consequences are devastating for both the consumer and the processor when it does occur. The presence of *L. monocytogenes* in raw ingredients emphasizes the importance of adequate cooking (thermal processing) to destroy the organism.

Employee training is another step in controlling the problem. Employees must understand the organism, observe basic sanitation principles, and gain the same sense of personal responsibility exhibited by management and regulatory officials.

The U.S. Department of Agriculture, Food Safety Inspection Service (FSIS) has instructed plants that produce RTE products to address control measures for *L. monocytogenes* in their Hazard Analysis and Critical Control Point (HACCP) plans. FSIS has provided guidance to the industry on practices that have been successful in meat and poultry operations to prevent the spread of *L. monocytogenes* in RTE meat. FSIS also has guidelines for product testing, conducted either by the plants or by FSIS inspectors. Testing for *L. monocytogenes* in 1998 has shown that its incidence is relatively high in many RTE products (Table 1).

Table 1. FSIS RTE Sampling Programs (1998).

Product category	Percent positive for *L. monocytogenes*
Sliced ham/luncheon meats	5.7
Small-diameter sausages	4.4
Salads and spreads	3.4
Roast/corned/cooked beef	3.1
Uncured cooked poultry	2.4
Large-diameter sausages	1.6
Jerky	0.7

Programs for Prevention and Control of *Listeria*

Plants must focus on preventing contamination of cooked products by *L. monocytogenes*. *L. monocytogenes* contamination of cooked meat products most frequently occurs when a product or food-contact surface is contaminated between the cooking and packaging steps. However, *L. monocytogenes* can also be introduced into the processing area from or by employees, equipment, animals, environmental reservoirs, or ingredients. The primary sources of *L. monocytogenes* contamination within food-processing plants are:

a) employees, through their clothing, gloves, boots, or skin coming into direct contact with the product

b) improperly cleaned and sanitized equipment

c) the environment, through airborne bacteria or aerosol moisture droplets generated in other work areas

L. monocytogenes can grow in cool, damp environments such as those found in any processing area, in coolers, or on slaughter floors. Improper sanitation and/or incomplete removal of meat and fat from processing equipment can allow biofilms to develop. These biofilms provide nutrients and a place of attachment for growing bacteria, including *L. monocytogenes*.

Products that have been fully cooked and will be consumed as packaged, without further heat treatment, present the highest risk to consumers if contaminated with *L. monocytogenes*. In order to control *L. monocytogenes* contamination, plants must assess their product flow and identify the most likely sites of contamination. A pre-processing checklist has been developed to help processors evaluate areas of high risk (see appendix).

Potential Product Sources of *L. monocytogenes*

- Raw product and ingredients (meat and poultry)
- Solutions to chill foods (ex: brine solutions)
- Loose product
- Rework
- Returned product

Possible Post-Cooking Product-Contact Surface Areas Contaminated with *L. monocytogenes*

- Slicers and dicers
- Saws
- Casing peelers
- Shelves and racks
- Lugs, tubs, and containers
- Hand tools, gloves, and aprons
- Packaging materials
- Packaging equipment
- Tables (see Figure 2)
- Conveyors and belts
- Sponges and brushes for cleaning

Figure 2. If used for raw products and not cleaned and sanitized properly, tables may be a source of *L. monocytogenes* contamination for ready-to-eat products.

In addition to contamination at food-contact areas, many opportunities exist for contamination from the environment. *L. monocytogenes* can flourish in many nonprocessing areas and may contaminate product contact areas under certain conditions. For instance, spray from hoses may splash or atomize and carry *L. monocytogenes* from floors or drains onto tables or equipment.

Potential Reservoirs of *L. monocytogenes* in Small Processing Plants

- Floors and drains (see Figure 3)
- Standing water (see Figure 4)
- Ceilings and overhead pipes
- Refrigeration/condensation units (see Figure 5)
- Wet insulation (exposed to processing area)
- Cleaning tools (sponges, brushes, squeegees) (see Figure 6)
- Overhead rails and trolleys (see Figure 7)
- Maintenance tools (wrenches, screwdrivers) (see Figure 8)
- Wooden pallets
- Forklifts and pallet jacks

Knowing the location of potential sources of contamination is very important in producing a safe RTE product, as most outbreaks and recalls are due to post-processing contamination. In general, once proper cooking has occurred, manufacturing a safe product depends on proper sanitation, limited handling, and elimination of cross-contamination in the RTE processing areas.

Figure 3. Due to the moisture content and difficulty during cleaning, drains are a potential reservoir of *L. monocytogenes* or *Listeria* spp. in processing establishments.

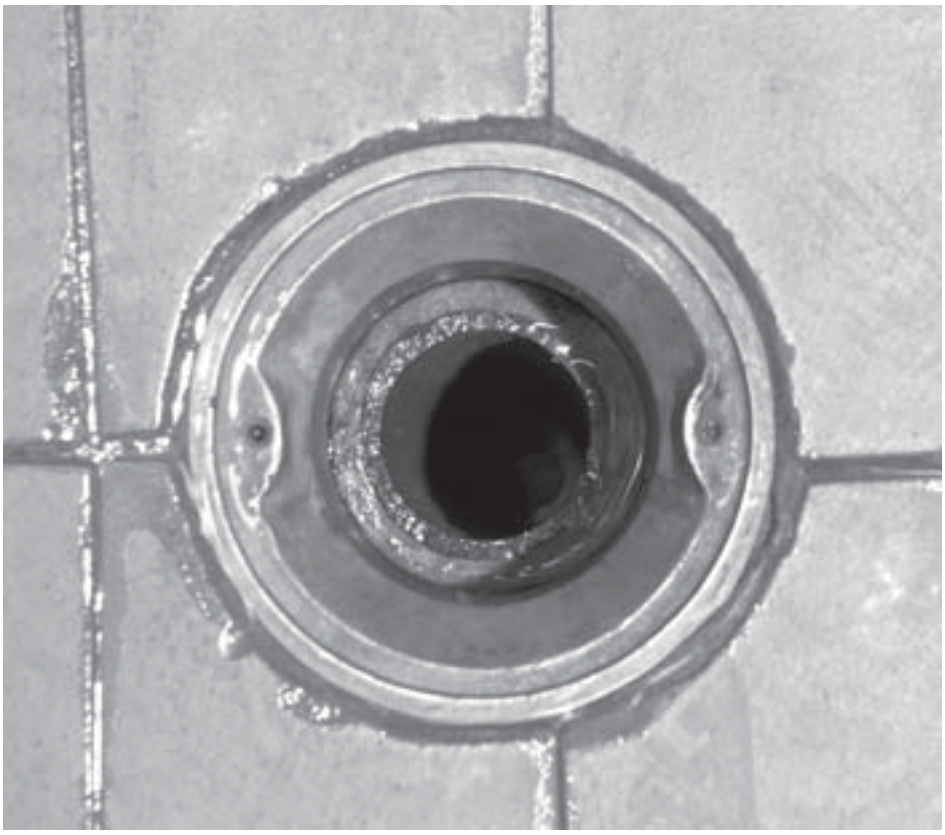


Figure 4. Standing water may be a potential reservoir of *L. monocytogenes* or *Listeria* spp. in processing establishments.

Figure 5. Overhead refrigeration and/or condensation units may be a source of *L. monocytogenes* or *Listeria* spp. if they drip onto ready-to-eat processing areas.

Figure 6. To prevent cross-contamination from raw to ready-to-eat areas, it is important to use cleaning tools, such as brushes, for one job only and to replace them periodically.

Figure 7. *L. monocytogenes* can travel throughout the plant in water droplets generated by the use of high-pressure hoses. Once they have found a surface to attach, *L. monocytogenes* can survive in dry and difficult-to-clean environments, such as overhead rails and trolleys.

Figure 8. Maintenance tools used in raw areas may be a source of cross-contamination in ready-to-eat areas if they are not properly cleaned and sanitized prior to use.

Other Areas for Potential *L. monocytogenes* Contamination

- Any recess or hollow object (rollers, switch boxes, box cutters, motor housings; see Figure 9)
- Rusted materials (equipment frames, pipes, shelving; see Figure 10)
- Cracked or pitted rubber hoses, door seals, walls (see Figure 11)
- Icemakers
- Air filters
- Open bearings
- Wheels (see Figure 12)
- Light switches (see Figure 13)

Figure 9. Hollow table legs in RTE areas may trap food and water, creating a harborage site for *L. monocytogenes.*

Figure 10. Rusty and pitted surfaces, such as this drain cover, may be a source of *L. monocytogenes* contamination on non-food-contact areas.

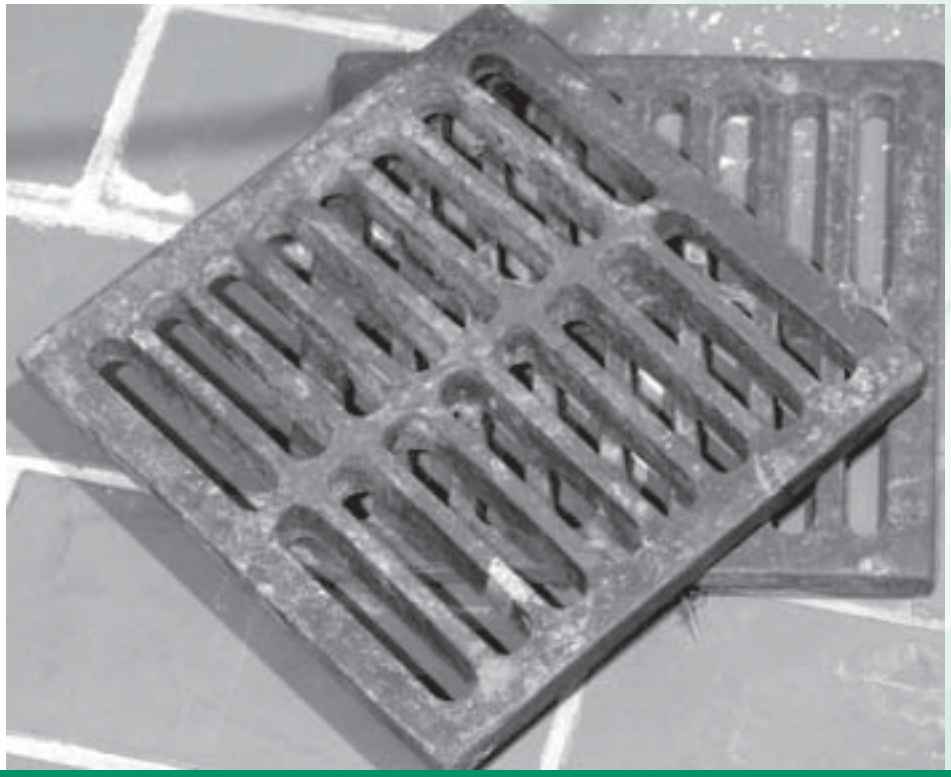
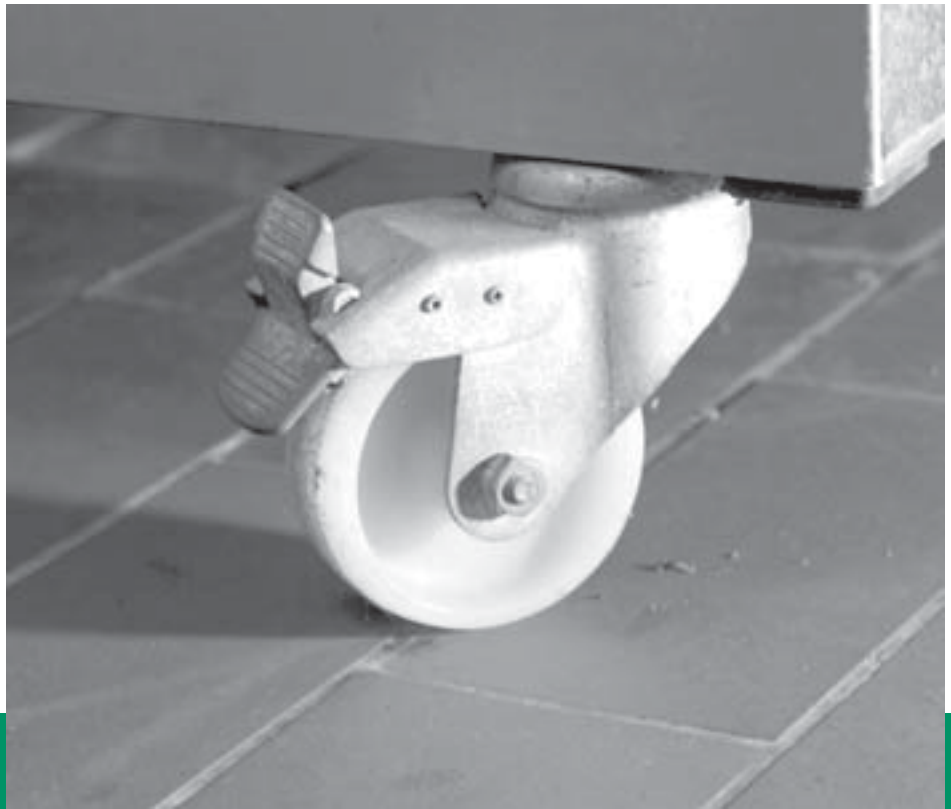


Figure 11. Since they come in direct contact with floors and drains, cracked hoses may be a source of *L. monocytogenes* contamination in processing establishments.

Figure 12. Wheels should be covered to prevent splash from the floor or drains. Wheels also should be easily cleaned to prevent cross-contamination of *L. monocytogenes* between raw and ready-to-eat areas.



Do you manufacture products that will support the growth of *L. monocytogenes*?

Processors of RTE products should ask three questions when determining the risk of exposure of their products to *Listeria monocytogenes*:

1) Do validation results support the efficacy of kill steps used in processing?

2) If products are exposed to an environment not known to be free of *L. monocytogenes*, what post-processing steps, if any, are in place to prevent contamination in that environment?

3) What does the finished product testing reveal about the status of the products with respect to *L. monocytogenes* contamination?

In order to be guaranteed incapable of supporting the growth of *L. monocytogenes,* a product must have at least one of the following characteristics:

a) Water activity (A_W) value of 0.85 or less

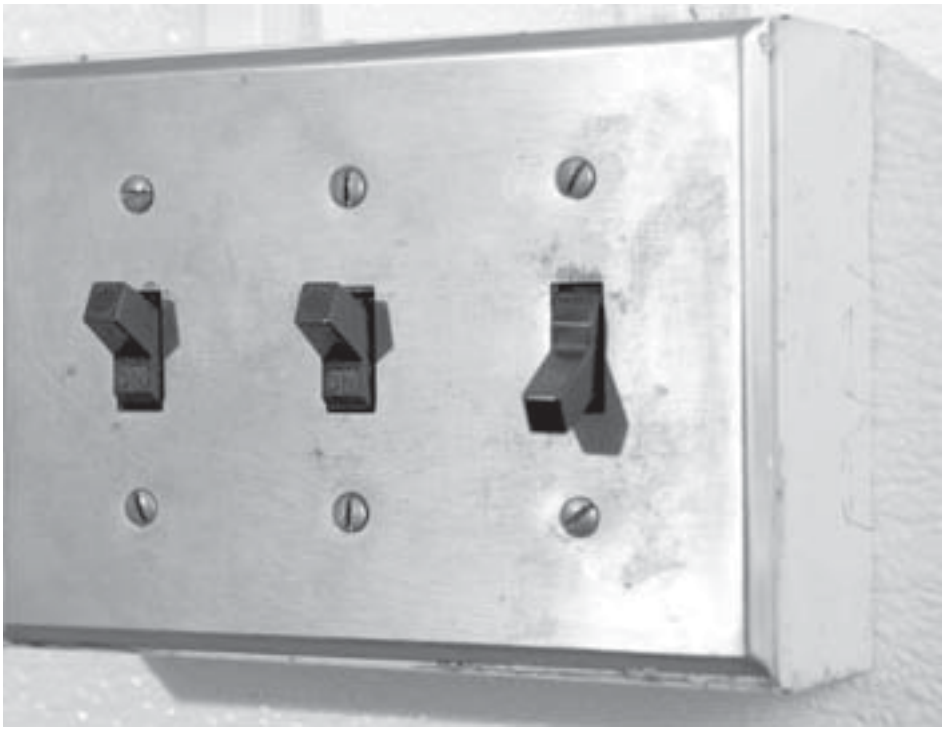
b) pH at 4.6 or below when measured at 75°F

c) Stored in an unopened, sealed container that is commercially sterile under nonrefrigerated storage (retorted or aseptically filled)

d) Laboratory evidence demonstrates that the growth of infectious or toxigenic organisms cannot occur

e) Composition of product naturally does not support the growth of microorganisms

Figure 13. Light switches may be another source of contamination of *L. monocytogenes* in ready-to-eat areas.



Since *L. monocytogenes* is relatively easy to kill by thermal processing, the chief concern in controlling *L. monocytogenes* is the prevention of recontamination after cooking. It is important to verify that all thermal processes and procedures meet the requirements for pathogen destruction.

Listeria monocytogenes control methods

There are many considerations for controlling *L. monocytogenes* in RTE products. Some of these include:

Levels of contamination in raw ingredients.
One-third of raw, commercially available ground chicken and turkey and about 10 percent of broiler carcasses, cow and bull carcasses, and raw ground beef harbor *L. monocytogenes*. Also, 4–7 percent of turkey carcasses, hog carcasses, and steer and heifer carcasses have been found to harbor *L. monocytogenes*. Given these high levels of contamination in raw products, having processes that will eliminate the organism is important. Prerequisite programs such as Good Manufacturing Practices (GMPs) and Sanitation Standard Operating Procedures (SSOPs) are critical in controlling *L. monocytogenes* in processing establishments.

Sanitation.
Sanitation is critical for ensuring that RTE products do not become recontaminated.

SSOPs should be established to provide effective and consistent results. Effective equipment sanitation includes the following steps:

1) dry cleaning
2) prerinsing
3) foaming and scrubbing
4) rinsing
5) application of chemical sanitizers
6) visual inspection of equipment
7) drying or removal of standing water (drying is important because it reduces the opportunity for *Listeria* to grow on floors—this—organism needs moisture to grow.)

Processors can establish the effectiveness of plant sanitation and learn the location of potential sources of contamination by conducting baseline microbial testing of both environmental and contact surfaces. These tests include microbiological analyses, including Aerobic Plate Counts (APC), generic *Listeria* or *Listeria* species (spp.), or ATP bioluminescence assays (see Figure 14). These can all be used to gain information about cleaning and sanitation procedures.

Figure 14. ATP bioluminescence systems are real-time tools that can be used to assess information about sanitation procedures.

Frequency of sanitation will be determined, to some extent, by the type of products and the risk involved (see Table 2). Equipment and tools that are only used to process RTE products should be sanitized before and after use. Do not place equipment parts on the floor to clean them. When cleaning product and equipment storage rooms, personnel must be careful not to splash water from the floor onto the product, thus possibly contaminating it with bacteria. Pay close attention to difficult-to-clean places where bacteria may easily hide (see Figures 15 and 16).

Sanitizers that have proven most effective against *L. monocytogenes* are quaternary ammonia compounds (quats), chlorine solutions, and newer products containing peracetic acid. Some plants rotate sanitizers periodically (every month or two) to prevent bacterial resistance against any one sanitizer. Choose appropriate acid-based detergents to avoid "soapstone" or hard-water buildup that can lead to biofilms. Some plants alternate detergents, which changes the pH and may keep bacteria from adapting to a particular environment. (Care must be taken *not* to use chlorine and acid-based detergents simultaneously, due to potential chemical hazards to employees.) Processors should work with suppliers of these products and/or with sanitation professionals to develop specific usage plans for each particular operation.

Table 2. Recommended Frequency of Cleaning and Sanitizing

Area	Frequency
All processing equipment	Daily
Floors and drains	Daily
Waste containers	Daily
Storage areas	Daily
Walls	Weekly
Condensate drip	Weekly/monthly
Coolers	Weekly/monthly
Freezers	Semiannually

Figure 15. Tight spaces between walls and equipment may be difficult to clean, but also can be sources of *L. monocytogenes* contamination.

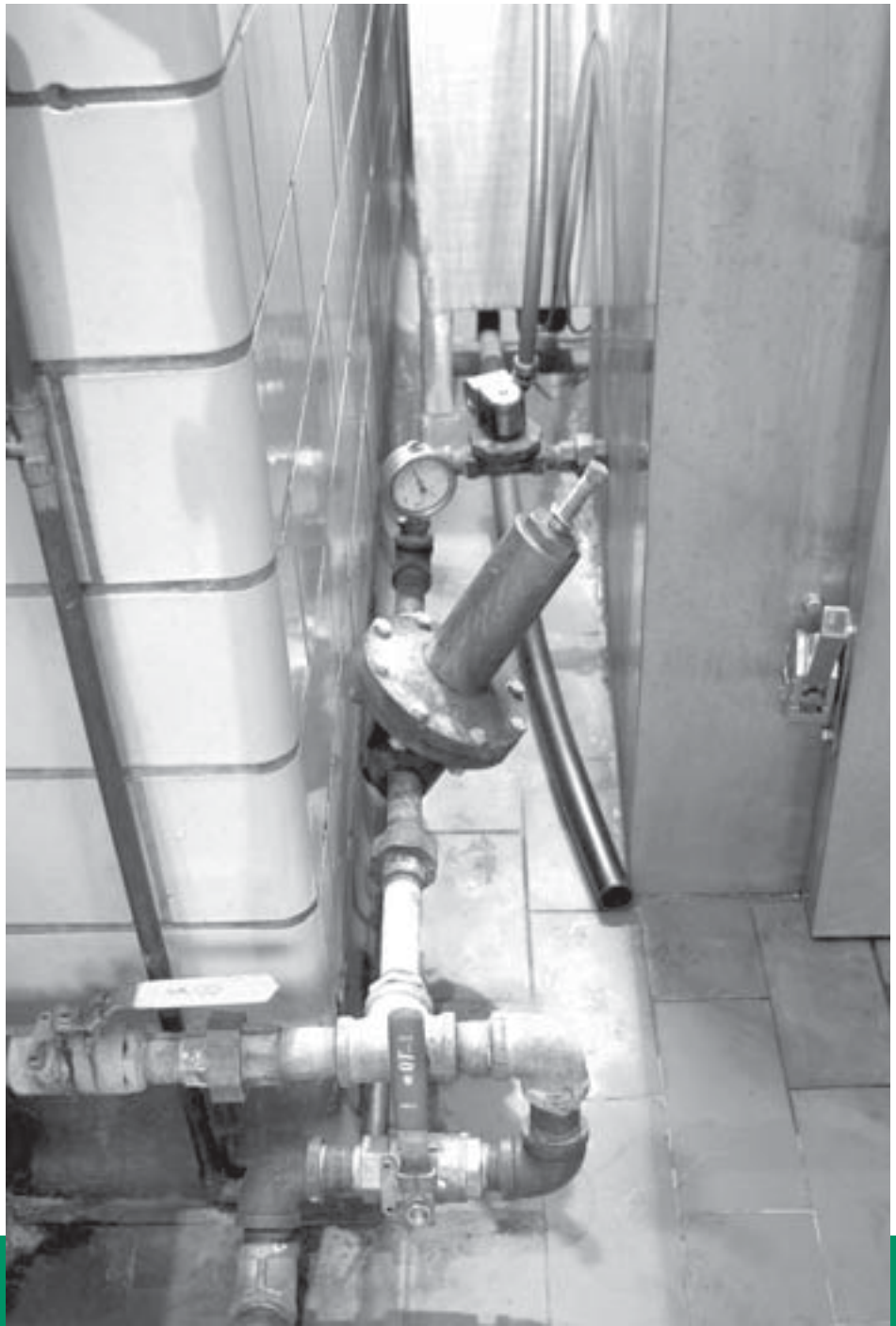
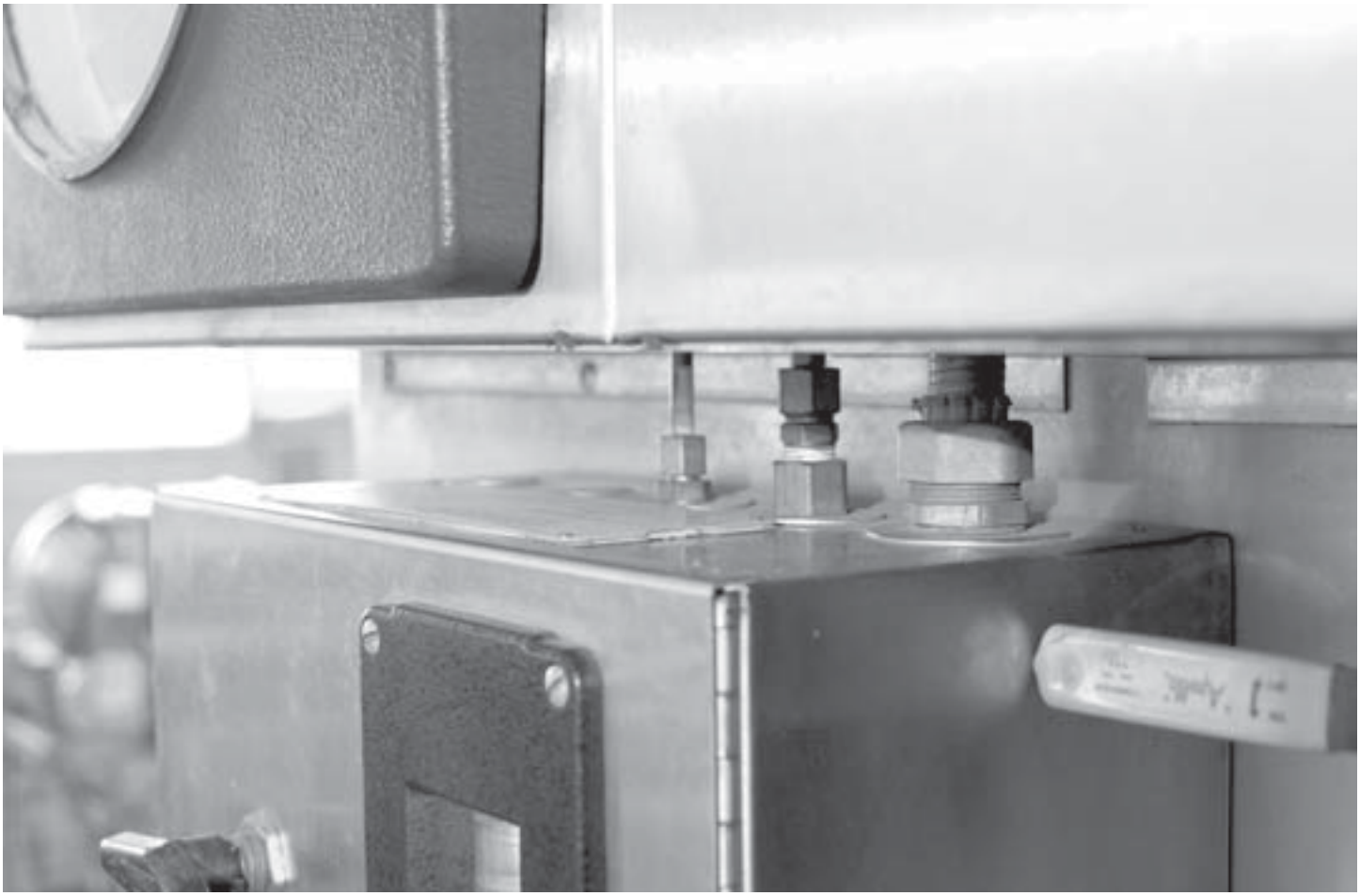


Figure 16. During sanitation, it is important to remember to pay close attention to difficult-to-clean areas such as spaces between equipment.



Plant design.
Many smaller plants in operation today were not properly designed to prevent cross-contamination of processed meat products. The following are some suggested design improvements for optimal contamination prevention.

a) The storage of products, product flow, and the movement of people between raw and RTE areas are all very important. One of the first things that must be done is to eliminate traffic flow between RTE and raw areas—RTE products—*must not* come into contact with or be in proximity to raw products.

b) RTE areas should be equipped with dehumidifying cooling units and drip pans for handling condensation. These units should be directed away from products in these areas and sanitized regularly. Make every effort to eliminate condensation in RTE work areas and coolers.

c) Ceilings, floors, and walls should be smooth, sealed, and moisture-free (see Figure 17).

d) Air supply ducts should be filtered to prevent contaminants from entering the building or the room. RTE product storage rooms should be under positive air pressure so that air is not received from unfiltered or raw-product areas.

e) Light fixtures should be designed so as not to collect dirt or moisture. Remove any difficult-to-clean overhead light fixtures from areas where RTE products are exposed (see Figure 18).

Figure 17. Cracks in wall boards may allow bacteria and moisture to become trapped in the insulation, creating an environment that allows for growth of *L. monocytogenes*.

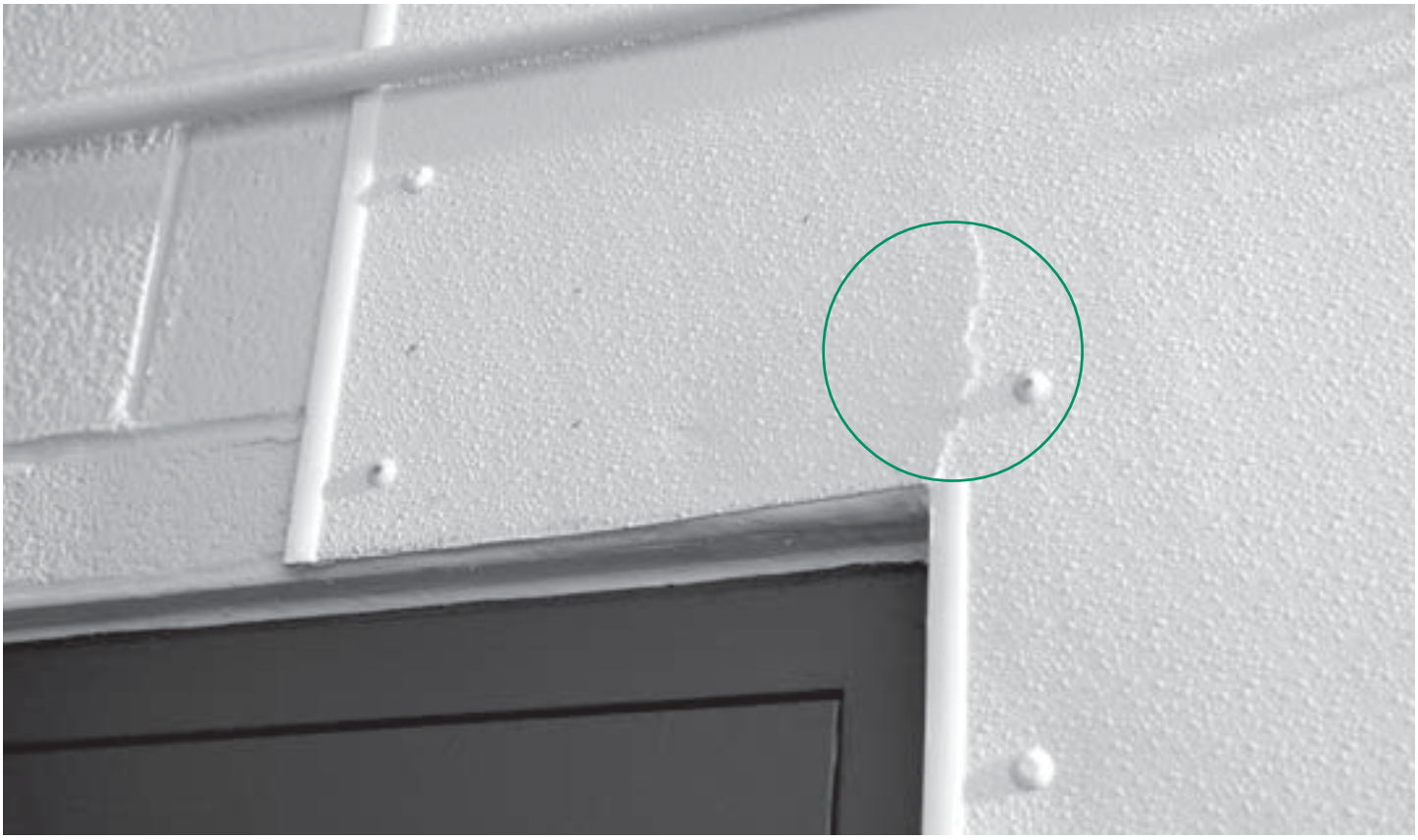


Figure 18. Since *L. monocytogenes* can survive in dry environments, pay careful attention to or replace difficult-to-clean overhead structures and light fixtures.

Testing for *L. monocytogenes* or *Listeria* spp.

Regulators believe that *L. monocytogenes* may be a food safety hazard reasonably likely to occur in the production process for RTE products. The purpose of conducting an environmental monitoring program is to identify any problem areas within the plant processing environment that may harbor *Listeria* and serve as sources of product contamination. Clear identification of these areas allows cleanup and sanitation efforts to be refocused so that the potential sources of contamination are eliminated.

Listeria monocytogenes is the only *Listeria* species associated with foodborne illness. However, environmental monitoring programs are interested in finding any type of *Listeria* (generic *Listeria* species). If a particular area of the plant environment is supporting one type of *Listeria,* it could just as easily support others, including *L. monocytogenes*.

Environmental monitoring requires taking microbial samples from different areas throughout the processing environment. Sampling sites and sampling frequency should be determined based on the features of the plant, type of product, plant layout, and product flow. The other consideration is whether to test only for *L. monocytogenes*, the specific pathogenic organism, or for any and all *Listeria* spp. Typically, processors consider three general types of testing for *Listeria* spp.: environmental (non-food-contact surfaces), equipment (food-contact surfaces), and product.

Environmental testing (non-food-contact surfaces).
These tests involve sampling in the post-cooked processing and packaging areas. They can be used to evaluate the effectiveness of existing sanitation programs and to develop methods to improve these programs. Tested areas could include air-handling units, vents, packaging, drains, wheels, floors, walls, ceilings, frocks/aprons, or the air (see Figures 19 and 20). Positive tests for *L. monocytogenes* or other *Listeria* spp. indicate that the sanitation program has failed and additional attention must be devoted to preventing the introduction of *Listeria* spp. into the RTE processing areas. More specifically, positive tests may indicate problems with airflow, in-plant traffic patterns, or personnel hygiene (including handwashing, dirty frocks or aprons, or improper movement between raw-product areas and cooked-product areas). Occasional positive environmental tests should not trigger a product recall. However, frequent positive tests should be of concern to the processor and indicate that regular product testing should be conducted to ensure product safety.

Figure 19. If also used for raw product packaging, vacuum packagers may be a source of *L. monocytogenes* contamination for ready-to-eat products.

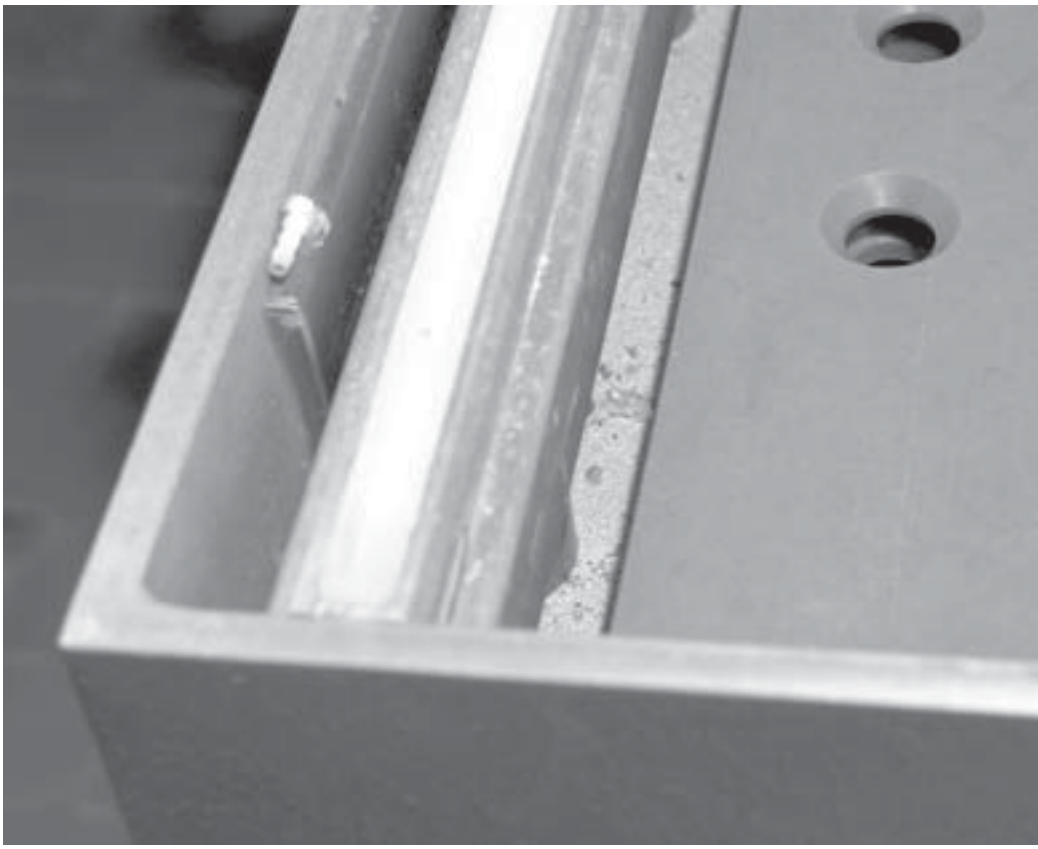
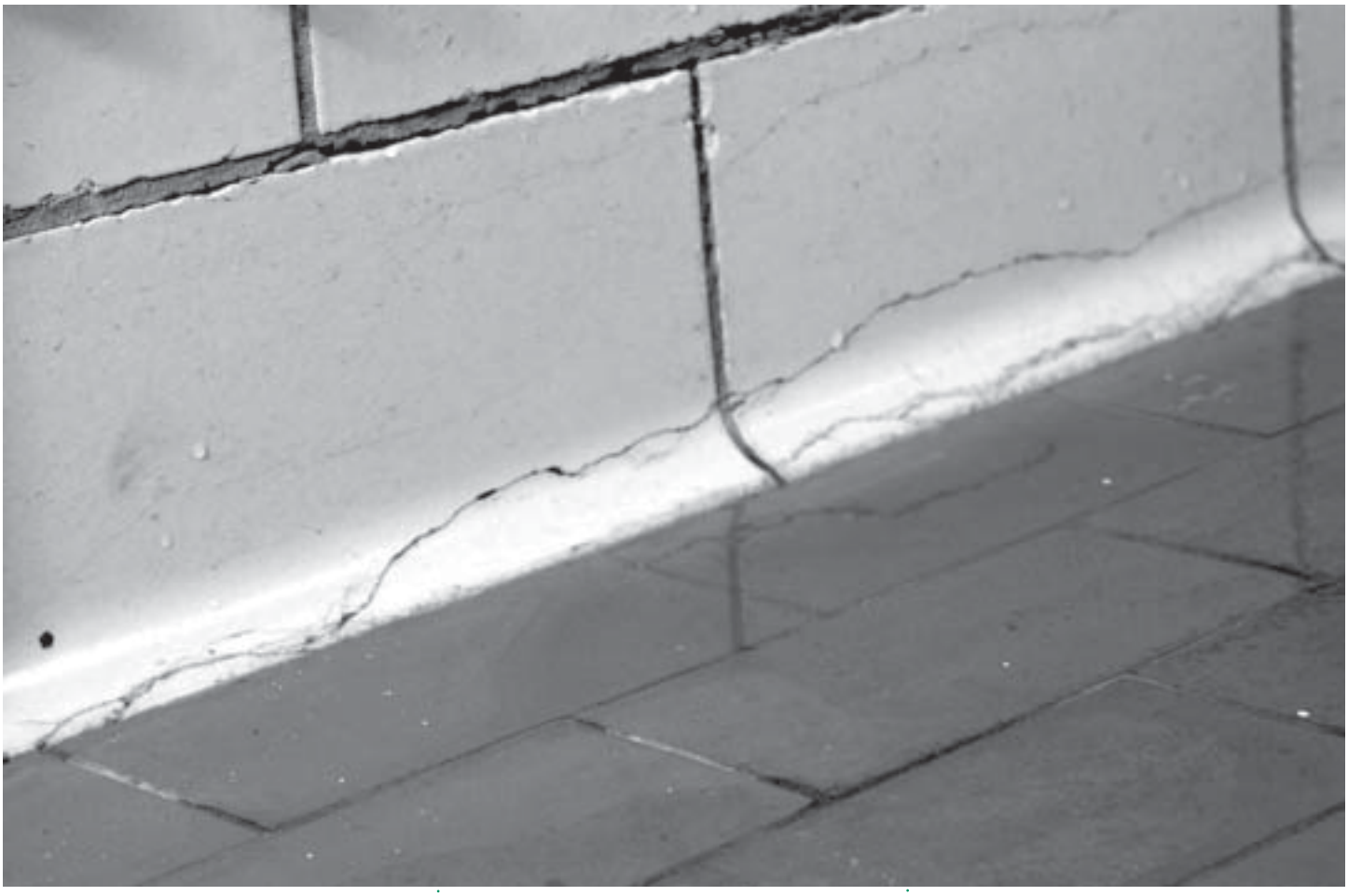


Figure 20. Cracks in flooring material may be a potential site of *L. monocytogenes* contamination.

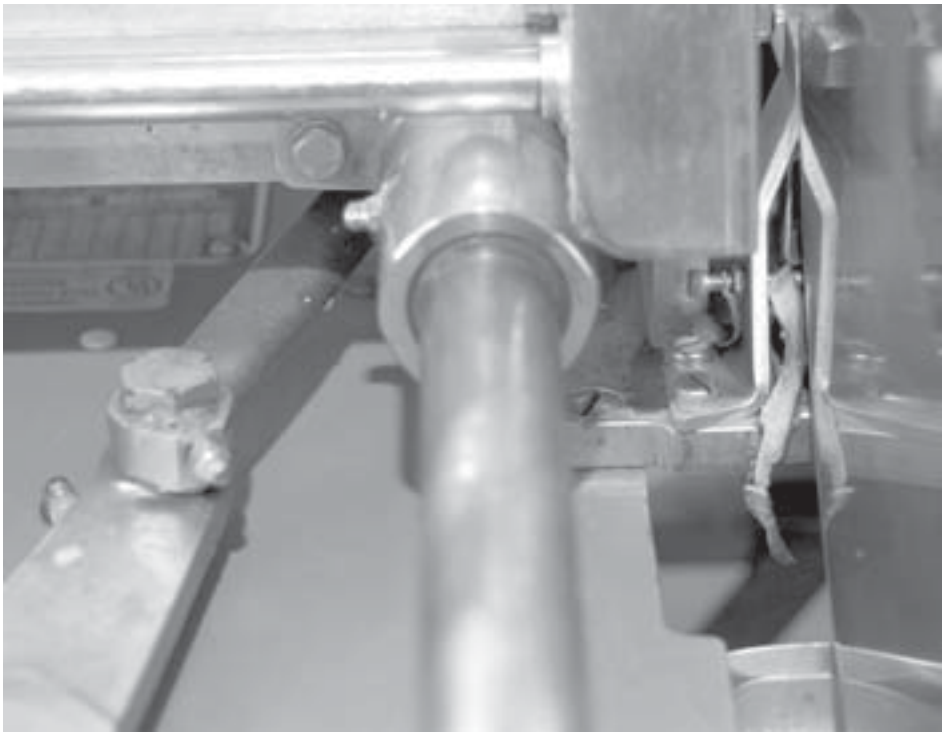


Food-contact surface testing.
These tests examine any equipment that comes into contact with pre-cooked or RTE products. These surfaces include tables, slicers, peelers, packaging equipment, and hand tools such as knives (see Figure 21). Testing could be for either *L. monocytogenes* or *Listeria* spp. A positive contact surface test for *L. monocytogenes* implies that the finished product that has touched that surface may be contaminated with *L. monocytogenes*.

Product testing.
Product testing is one method to determine if *L. monocytogenes* or *Listeria* spp. is present on the product. However, negative results can create a false sense of security since the small amount sampled may not accurately reflect the presence or absence of *Listeria* in the rest of the product. Although product testing is considered the best test for detecting the presence of *L. monocytogenes*, it requires that the entire lot of a tested product be held until test results are received, which may take up to 48 hours. For many processors, it is not feasible to do this regularly due to a lack of storage space for finished products.

Regulations require periodic testing of finished product to verify that the process controls for eliminating *L. monocytogenes* are effective. Tests for *Listeria* spp. may be conducted in-house by an establishment, but these should be validated regularly by an outside laboratory. However, processors should seriously consider their options before conducting in-house *L. monocytogenes* tests, due to the possibility of further cross-contamination from the laboratory to the plant.

Figure 21. Food-contact surfaces, such as slicers, should be tested periodically for *L. monocytogenes* or *Listeria* spp.



General Procedures for Sampling *Listeria*

- A responsible employee with proper training should be chosen to conduct this testing. It is important to have the same employee conduct the testing on a regular basis to ensure the consistency of the procedures.
- Samples must always be taken in the same manner and be of the same size area sampled.
- For large, flat surfaces such as tables, floors, drip pans, etc., swab an area of 100 square centimeters by rubbing a moistened sponge back and forth across it; then flip the sponge over and swab the same area perpendicular to the original sponge strokes (see Figure 22).

Figure 22. Large flat surfaces, such as conveyors, are best sampled for *L. monocytogenes* or *Listeria* spp. using a sterile template (10 cm x 10 cm) and a moistened sponge.

- Remove drain covers and swab the interior surfaces and throats of the drains (see Figure 23).
- For small or confined spaces (chain conveyor links, machine interiors, knife holders, etc.), swab several spaces or as large a total surface area as possible (see Figures 24 and 25).
- Make sure the sponge bag is clearly marked with the sample date, sample location, and company name.
- Keep good records of exactly where each sample was taken.
- If the sampled area is a food-contact surface, it is advisable to sanitize the swabbed area immediately after sampling. By doing this, any questions are eliminated about the disposition of the product that touched that surface if the tests are positive for *Listeria.*
- If *Listeria* is found, clean-up and sanitation efforts should be intensified in that area to eliminate the source and keep it under control. After several weeks of intensified cleaning, the same area(s) should be resampled to verify that the contamination has been eliminated.

Figure 23. In order to swab drains adequately for *L. monocytogenes* or *Listeria* spp., remove drain covers and swab the interior surfaces and throats of the drain with a moistened sponge.

Figure 24. Smaller, tight-fitting or confined areas are best sampled for *L. monocytogenes* or *Listeria* spp. using a sterile template (2" x 2") and a moistened cotton swab.

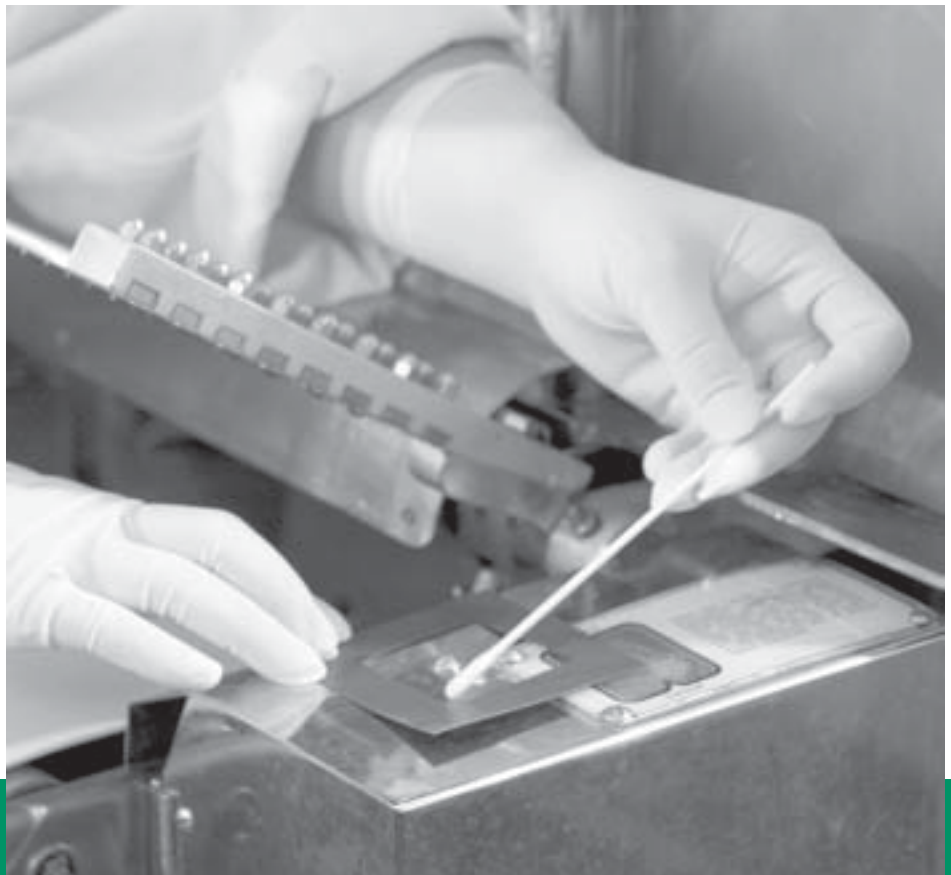


Figure 25. Machine interiors, such as deli slicers, can be assayed for ATP bioluminescence or sampled for *L. monocytogenes* or *Listeria* spp. by swabbing several sites using a moistened sponge.

Implications for HACCP

Hazard Analysis

Given the number of meat products that test positive for *L. monocytogenes* (see Table 1), there is an overwhelming scientific basis for recognizing that contamination of RTE meat products by the pathogen is likely to occur. This means that in the case of all products that will support the growth of *Listeria* after thermal processing, the hazard analysis portion of the HACCP plan must address the control of *Listeria.*

Critical Control Points (CCPs)

For most RTE products, it is likely that a CCP already exists to ensure the thermal destruction of pathogens. This CCP should remain in place, but an additional CCP will probably need to be developed to address the prevention of cross-contamination of the product after thermal processing. Plants that have a regulatory requirement for HACCP are already operating under sanitation programs called Sanitation Standard Operating Procedures (SSOPs). In many cases, all or part of an SSOP may be transferred to the actual HACCP plan of a plant as sanitation becomes recognized as critical to the production of a safe meat product. There is no step later in the process that will control the hazard. The details of this transfer will vary from plant to plant and even product to product, based on the analysis and control methods chosen to address each potential hazard. Examples of CCPs developed from SSOPs might include:

- personal hygiene
- using color-coded clothing, such as blue frocks for RTE areas and white for raw product areas
- recording the application and concentration of chemical sanitizers
- use of microbiological or ATP bioluminescence tests to determine effectiveness of cleaning and sanitizing programs

Critical Limits (CLs) and Records

All CCPs must have a critical limit (CL) that is both observable and measurable. "Measurable," in this case, means that careful records must be kept of a wide range of variable factors, from the number of violations of a clothing policy to the amount of chemical sanitizer used in an area over a given period of time.

Verification/Corrective Actions

Verification of sanitation procedures should be conducted periodically in small plants to reassure plant operators and inspectors that a sanitation program is effective in preventing the presence of *L. monocytogenes* on equipment surface areas and in the final product. Microbial swab tests on equipment and/or product should be used to verify the program's effectiveness (see discussion of testing procedures above).

Positive tests for *L. monocytogenes* either on contact surfaces or in finished product should initiate corrective action (CA). The CA would likely start with testing finished product to ensure that no contaminated product reaches the consumer. The next step would be to reexamine the sanitation program to determine how the contamination occurred. This may lead to reevaluation of the critical limits and record-keeping procedures.

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Appendix

Checklists for *Listeria* control

Listeria monocytogenes can be controlled through strict prevention principles in facilities that manufacture RTE products.

The following series of questions is designed to help small processors perform a risk assessment of *Listeria* contamination in their facilities. These questions are quite specific to certain processes and may not be applicable to all processors. Processors may wish to select the most relevant questions for their operations and develop their own lists to be checked on a weekly or monthly basis.

Facility design/product separation

1) Is the facility designed to prevent RTE employees from traveling through areas where raw product is processed or stored?

2) Can feasible modifications to the facility improve personnel traffic patterns?

3) Is the facility designed to keep RTE product separate from raw and partially cooked product?

4) Can feasible modifications to the facility ensure the separation of raw and fully cooked product?

5) Is production scheduled to minimize the possibility of cross-contamination from raw product and personnel?

6) Are raw materials being stored in separate areas from the finished product?

7) Is the facility designed to promote the highest possible degree of personnel hygiene?

8) Are processing facilities, locker rooms, lunchrooms, or walkways shared between RTE handlers and raw-product handlers?

9) Does product ever incidentally come in contact with walls?

10) Are there footers at the bases of walls to keep product from coming in contact with the walls?

11) Is there positive air pressure in the RTE areas?

12) Is all compressed air filtered within the facility?

13) What can be done to eliminate condensation in the facility?

14) If eliminating condensation is not feasible, what can be done to redirect or capture condensation?

15) Are certain areas especially prone to condensation?

16) Can product be directed away from areas that are prone to condensation?

17) Are floors nonporous and sufficiently cleaned and sanitized to prevent contamination?

Personnel sanitation/hygiene

1) Are all employees trained in proper hygiene and food-handling procedures?

2) Is food safety education incorporated into "on-the-job" or "hands-on" training?

3) Does management set an example by following proper food-handling procedures?

4) Is there someone in the plant who can provide an unbiased evaluation of the effectiveness of the SSOPs?

5) Do employees wash and sanitize their hands after touching any nonfood item and before handling RTE product?

6) Can one employee be designated to handle all "dirty" items such as trash, pallets, etc.?

7) Are there separate color-coded garments for RTE and raw personnel?

8) Do RTE handlers wear disposable gloves, aprons, sleeves, etc.?

9) Do RTE handlers change disposable garments often enough to prevent cross-contamination from packaging materials, pallets, etc.?

10) Do RTE handlers open products carefully, so as to prevent cross-contamination from the outside of the shipping container?

11) Are reusable packaging materials (e.g., plastic buckets used for ham, chicken, or turkey salad) properly cleaned and sanitized before use?

12) Has plant sanitation ever been audited by an outside source (e.g., cleaning product suppliers)?

Equipment and supply sanitation

1) Are the chemical sanitizers used in the facility approved for controlling *Listeria*?

2) Are the chemical sanitizers specific for controlling *L. monocytogenes*?

3) Are the packaging areas and RTE product storage areas cleaned and sanitized regularly to prevent cross-contamination?

4) Are packaging supplies stored in a sanitary manner before use?

5) Are there floor, boot, and wheel sanitizers located in key areas throughout the facility?

6) Are smoke trucks and racks high enough off the floor to prevent contamination from water splash?

7) Do wheels have splash guards?

8) Is cooked product removed from coolers before cleaning?

9) Are rails, pipes, lines, ledges, lights, etc., cleaned and sanitized to prevent overhead contamination?

10) Are cooling units designed to prevent overhead contamination?

11) Are cooling units and drip pans cleaned and sanitized on a regular basis?

12) Are drains cleaned and sanitized to prevent contamination?

13) Do drains regularly clog and backflow onto production area floors?

14) Are strict precautions and sanitation measures in place in the event of flooding due to drain backup?

15) Is there standing water in any RTE areas? Can the standing water be eliminated?

16) What precautions can be taken to avoid the accumulation of standing water?

17) Are walls cleaned and sanitized on a regular basis?

18) Are door handles, openers, switches, and buttons cleaned and sanitized on a regular basis?

19) Is packaging equipment placed well away from walls to provide ample room for complete sanitation of the walls and equipment?

20) Are nonproduct contact areas cleaned and sanitized on a regular basis?

21) Are steam lines and shutoff valves free of leaks?

22) Does the same sanitation crew clean both RTE and raw areas?

23) Is it feasible to have separate sanitation crews for RTE and raw areas?

24) Are there separate cleaning supplies for RTE and raw areas?

25) Are cleaning supplies disposable?

26) Are nondisposable cleaning supplies heat-pasteurized and stored in chemical sanitizer?

27) Are disposable wipes used instead of rags?

28) Are squeegees used instead of mops?

29) Do brooms and brushes have plastic handles and bristles?

30) Are hoses cleaned and sanitized after each use?

31) Is cleaning equipment cleaned and sanitized in the same manner as processing equipment?

32) Are peelers completely disassembled, cleaned, and sanitized after each use?

33) Are peeler blades disposed of after each use?

34) Are link cutters completely disassembled, cleaned, and sanitized after each use?

35) Are conveyors and belts completely disassembled, cleaned, and sanitized after each use?

36) Are cutting boards, band saws, and slicers cleaned and sanitized after processing bacon or partially cooked smoked pork products, and before processing RTE products?

37) Are hand tools cleaned and sanitized after each use?

38) Are there separate tools, knives, lugs, and tubs for RTE product, rework, etc.?

39) Are molds and dies cleaned and sanitized on a daily basis?

40) Does the packaging equipment undergo routine maintenance and internal sanitation?

Process verification

1) Does the product support the growth of *L. monocytogenes* (ex: high pH in fermented sausage; moisture activity in jerky)?

2) Is the process validated by supporting scientific documentation?

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Scanning electron micrograph of the bacterium *Listeria monocytogenes* used in Figure 1 and on front and back covers copyrighted by Dennis Kunkel Microscopy, Inc.

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