

Guide for the prevention, monitoring and elimination of listeria in the salmon industry

A delivery in the project "Measures for increased control of listeria in the salmon industry"

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About the guide

The purpose of the guide is to describe practical procedures and chemical/technical solutions for preventing and combating *Listeria monocytogenes* (referred to as listeria) in plants producing gutted, filleted, smoked and/or graved salmon and trout. The guide is a tool for targeted measures to increase control of listeria in such production plants. This guide highlights only the most important elements of combating listeria in production plants and is intended as a supplement to existing guides and reports. See page 13 for some relevant reports. Of special relevance is the Codex Alimentarius Guidelines CAC/GL 61, 2007, describing areas and factors of the food chain that should be given special attention in production linked with listeria risks.

The target audience of the guide is personnel with responsibilities within quality management, quality assurance and production hygiene in plants processing salmon and trout (hereinafter collectively referred to as salmon).

The guide is structured around the areas of prevention, monitoring and problem-solving:

- 1 Prevention: How to prevent listeria problems from occurring?** How to prevent establishment and transmission of listeria in plants.
- 2 Monitoring: How to monitor listeria in plants?** How to establish risk-based monitoring and implement sampling in practice.
- 3 Problem-solving: How to get rid of listeria?** How to solve listeria problems using measures.

The key to combating listeria can be found in the everyday efforts in these three areas. This guide can contribute to the prioritisation and establishment of appropriate procedures and measures in individual production plants. These procedures should be incorporated into the company's HACCP system and measures for hygiene control. The combination of multiple elements in areas 1-3 will ensure good results and increased control of listeria in the salmon industry.

Recommendations in the guide are based on results and experiences from the projects "Measures for increased control of listeria in the salmon industry" (Norwegian title: Tiltak for økt kontroll med listeria i laksenæringen) and "Surveying corporate practices (product, process and organisation) that inhibit and promote the incidence of listeria in Norwegian salmon products" (Norwegian title: Kartlegging av bedriftspraksis (produkt, prosess og organisering) som hemmer og fremmer forekomst av listeria i norske lakseprodukter). Nofima has managed the projects and has been responsible for the practical implementation. The projects have been funded by the Norwegian Seafood Research Fund.

Facts about *Listeria monocytogenes*

- Widespread occurrence (e.g. soil, water, sewage and vegetation)
- Can cause serious disease (listeriosis) in both humans and animals
- Pregnant women, the elderly and people with impaired immune defence are at most risk
- Can become established in food production environments and infect raw materials and products
- Can grow at temperatures as low as 0°C, but is killed through heat treatment
- Risk products are long-lasting, refrigerated, ready-to-eat products including smoked salmon
- A number of food-borne listeria outbreaks, in Norway and abroad, have taken place but none of these have been linked to Norwegian salmon products.

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1 Prevention: How to prevent listeria problems from occurring?

The most important causes of listeria problems in processing plants are:

- 1 Listeria regularly enters the plant through raw materials or due to inadequate hygiene barriers
- 2 Preventative work is inadequate and contributes to the establishment of listeria in premises, machinery or equipment
- 3 Measures to prevent listeria in plants are missing or inadequate.

Preventative work is crucial for increased control of listeria in the salmon industry. Preventive actions must be targeted along the production chain and include raw material producers, harvesting sites and processing plants. Preventative measures should prevent listeria from entering the plant and prevent establishment in the production environment. Important points concerning preventative listeria work in plants have been included below. Examples of production conditions that are crucial causes of listeria problems in production plants are listed in Table 1.

1.1 Knowledge of infection sources and measures to reduce these

- **Raw material, salmon.** Set out requirements concerning listeria documentation from raw salmon suppliers. Verify the listeria status in raw materials from various suppliers. Gutted or filleted salmon has already passed through a production plant and the incidence of listeria will therefore be higher than for unprocessed salmon. Provide feedback to suppliers in the event of repeated findings and high incidences and set out requirements concerning measures on these suppliers.
- **Outdoor environment and unclean parts of the plant.** Establish zones, sluices and flow of personnel and equipment to prevent the introduction of listeria to production premises. Equipment used in one plant should not be brought into another plant before it has been documented that the equipment is not infected with listeria.
- **Personnel and visitors to the plant.** Any persons (employees, service and maintenance personnel, visitors) who enter the production premises must wear footwear, protective clothing (including hair nets), perform hand washing and wear gloves to prevent the introduction of listeria to the plant. Good sluice procedures are key to preventing the introduction of listeria. For visitors we recommend appropriate protective clothing (overalls or lab coats), gloves and hair nets for single use. Footwear should be easy to clean (e.g. rubber wellies) and must always be used and available to all personnel and visitors. Shoe covers are easily damaged and unsuitable. Footwear should be changed between different zones and must always be changed when transferring from unclean to clean zones. The use of gloves should not replace hand washing in the sluice. Gloves should be changed after touching surfaces that do not come into direct contact with salmon (e.g. drains and floors).
- **Repairs and maintenance.** This work constitutes a risk for listeria transfer. Avoid maintenance and repair work during production. Make sure that there are procedures and training in place to ensure that all employees and external personnel (e.g. service personnel) comply with the hygiene procedures in the plant and thereby prevent infection in the plant. Tools can be a source of infection and should be disinfected before and after use. Always perform adequate cleaning after repairs and maintenance.

1.2 Production conditions and procedures to prevent establishment of listeria

- **Identify potential listeria niches** in the plant (production premises, machinery and equipment) and prioritise the removal or upgrade of these.

What characterises listeria niches?

Listeria niches are often:

- areas to which organic material is often introduced and difficult to remove through ordinary cleaning
- areas that are moist and rarely or never dry completely
- areas that are difficult to clean or that are not cleaned

In these sites, a listeria population ("house strains") specific to the processing plant, can establish, resulting in continuous listeria problems in the plant.

- Cleaning must be prioritised and it must be ensured that there are hygiene requirements for equipment and premises. Cleaning and hygienic design must be emphasised when investing in new equipment and in the event of alterations/new-builds. An emphasis on cleaning and hygienic design during procurement contributes to the development of machinery and equipment that is easier to clean. Ensure that the manufacturer agrees to provide training in cleaning, disinfection, maintenance and any dismantling of the specific equipment through agreements set out in the procurement contract.
- Monitor the listeria situation to ensure that changes are identified. Look at listeria findings as an indication of whether the monitoring programme is working.
- Establish a maintenance plan to ensure that damage, wear and corrosion on equipment and surfaces are repaired before becoming listeria niches.
- Invest in employees by providing excellent training and adequate resources (time, materials) to implement maintenance, cleaning and ensure that procedures are upheld.

If adequate cleaning is in place the elimination of listeria niches is the most important preventative work a plant can perform. Listeria niches increase the probability of growth, survival and spread of listeria. The niches protect the bacteria against e.g. cleaning, disinfection and drying.

Table 1 Procedures and conditions that experience finds to be linked to listeria problems.

Activity/production conditions	Why do problems arise?
Deviation from normal production	Greater production than normal, e.g. double shifts at the expense of time allocated for cleaning Shutdown and need for maintenance during production
Alteration of premises or production lines	Increased activity and transport in production premises carries an increased risk of spreading the disease Effective zone barriers are not practised
Temperature too high in production premises	High outdoor temperature, alterations and maintenance may result in the temperature being too high in the premises
Used equipment from other plants is installed	Listeria can survive for prolonged periods in equipment. A listeria problem can be introduced to the plant if acquiring used equipment that has previously been used in other plants
Violation of zone barriers	Especially in connection with trolleys, carriages, forklift trucks and personnel crossing from unclean to clean zones
Infection from unclean surfaces to product	Spray/flushing during production (e.g. floors and drains) onto contact surfaces may cause listeria infections Condensation droplets in the production line or during storage carry a risk of infection Risk products are handled in close proximity to listeria niches (e.g. drains) with a risk of transmission to products
Holiday temps in production	Inadequate training, understanding and application of hygiene procedures
Cleaning equipment contributes to infection	Inadequate maintenance of e.g. shoe cleaners may contribute to the spread of listeria. Cleaning equipment used across zones
Inadequate maintenance and prioritisation of measures	Reconditioning/removal of problem areas is not prioritised

2 Monitoring: How to monitor listeria in processing plants?

Monitoring of the listeria status in your own plant is crucial for:

- 1 quickly identifying if listeria problems arise
- 2 identifying contamination sources
- 3 evaluating whether processes, procedures and cleaning contribute to the desired control of listeria
- 4 clarifying the cause of the problems

Risk-based sampling will contribute to cost-effective monitoring for increased food safety.

2.1 Performing risk-based monitoring

Risk profiling of the production process should be performed based on the principles of the hazard analysis (HACCP). Contamination sources and processing routines with the greatest probability of listeria transmission to products are ranked highest.

Listeria contamination in production. Where is the highest risk?

The greater the probability of transmission to products, the greater the risk of listeria in the end product. The greatest risk is associated with:

- Direct transfer from contact surfaces to product. Examples: conveyor belts, gutting machines, slicing machines, gloves
- Indirect transmission to products from surfaces with a high incidence of listeria. Examples: condensation droplets from pipes and cooling systems in the production line or storeroom, infection from drains or floors through spraying during production.

Risk profiling provides the basis for selection of sampling locations and sampling frequencies that would be unique for each individual plant. Guidelines for risk-based monitoring are:

- 1 Perform risk profiling and prioritise sampling of locations ranked high in the risk profiling. Findings from previous sampling and knowledge of listeria niches, infection sources and routes of transmission form the basis for the risk profiling. A map of the production plant with an overview of the production process (production lines, zones, flow of personnel, goods and products) is an important tool.
- 2 Have a high number of sampling locations and a high sampling frequency when establishing the sampling programme. Adjust sampling based on findings and assessed risk. Changes to the processes and procedures, e.g. maintenance, implementation of new machines and equipment, new processes or new measures, may result in reduced or increased risk and should be assessed by auditing the sampling schedule. The plan should be audited every six months or more frequently.

2.2 Which sample types should be included in the monitoring plan?

Raw material samples. Raw materials can be a source of listeria. Processed salmon (gutted, filleted) often has a greater incidence of listeria than whole salmon. The use of multiple salmon suppliers results in less control and an increased risk of introducing listeria to your own plant. Requirements must therefore be set out for raw material suppliers concerning both sampling and listeria documentation. Raw material samples as part of the monitoring plan in own plant should therefore be limited. See section 2.3 for more information.

Samples from product contact surfaces and the environment. Listeria on product contact surfaces carries an increased risk of transmission to products. Product contact surfaces should constitute the majority of the sampling locations, and areas that may be difficult to clean and/or that constitute potential listeria niches must be especially prioritised. The production environment can be an important indirect source of infection. Focus especially on drains and floors as well as surfaces with a risk of condensation droplets near the process line.

Product samples. Product samples should be limited to a minimum but within the framework of regulations and customer requirements. Product samples are poorly suited for monitoring but can be included as part of the sampling programme for the purpose of verifying that production procedures and control programmes contribute to a low incidence of listeria in products. Sampling must be performed on the final, packaged end product.

2.3 When and how often should samples be taken?

Sampling of product contact surfaces and the environment should primarily be performed some time after cleaning but before start of daily production.

Should samples be taken before start of production or during production?

Sampling before start of daily production provides answers as to whether cleaning has the desired effect against listeria and detects listeria niches in the plant. Sampling during production can provide information about whether listeria is transferred from niches to production equipment, the environment and products during processing but it can be difficult to draw conclusions since listeria can also be introduced to the plant with the raw material salmon. The majority of samples should therefore be taken before daily production start.

The sampling frequency should be linked to risk and adjusted depending on results and experiences:

- 1 Conduct sampling of product contact surfaces on a rolling, weekly basis (or more frequently) to ensure that all locations included in the plan are sampled each month. Prioritise sampling from the processing lines used for production of ready-to-eat risk products.
- 2 Sample known risk locations and listeria niches weekly or more frequently.

- 3 In the event of positive findings, include the same sampling location in the next sampling. Extended sampling should be considered based on the risk of transmission to products (see "seek-destroy" strategy, Chapter 3).
- 4 Raw material suppliers are responsible for documenting the listeria quality of raw materials. Random sampling of raw materials from different suppliers may be necessary for the listeria documentation of raw materials used in own plant. Prioritise sampling of raw materials used for the production of listeria risk products. Prioritise raw materials with a higher incidence of listeria (gutted or filleted salmon rather than unprocessed and live salmon). Consider extended sampling of raw materials when using new suppliers for which the incidence of listeria is unknown and in periods historically linked to a high incidence of listeria, e.g. in periods with heavy rainfall and melting snow.
- 5 Revising the sampling plan. In sampling locations where listeria is rarely or never detected the sampling frequency should be decreased. Increased sampling frequency should be considered for areas showing high or increasing incidence of listeria and in any new potential listeria niches.

2.4 Pooled samples or individual samples?

More samples result in an increased chance of detection but also increased costs for sampling and analysis. A cost-effective solution could be the use of pooled samples where e.g. five individual samples are analysed as one pooled sample. But the use of pooled samples must be carefully considered. Pooled samples from different sampling locations taken using the same swabs would for example increase the risk of listeria spread and also provide limited information about the contamination source. Pooled samples from machines, equipment and production environments should therefore be avoided. The use of pooled samples of raw material from different individual suppliers should also be avoided but pooled individual samples from one raw material supplier could be considered. In the event of problems, sampling should be based on the "seek-destroy" method (Chapter 3).

2.5 Listeria sampling. Methods and practice

Appropriate sampling is crucial with regard to documenting listeria status in the plant. This requires sampling equipment suitable for the area and location to be sampled and that sampling is performed correctly. There is no standard methodology for listeria sampling from raw material fish, the environment, machinery or equipment. Several factors associated with equipment, methods and implementation have an impact on the results of the sampling.

Important factors when selecting sampling equipment

- Listeria can attach to surfaces and form biofilm. Force must therefore be applied to loosen listeria attached to surfaces. Sampling cloths may therefore be more appropriate than swabs, which could break.
- Sterile sampling cloths are very suitable for sampling of larger equipment and environment surfaces as well as salmon. Smaller swabs should be used only where sampling using cloths is not efficient (e.g. inside pipes, cracks, etc. where you cannot reach using a rag). Gauze pads and similar can be used for sampling in drains.

- Sampling of a large area increases the probability of detecting listeria. It is recommended that an area between 1000 and 3000 cm² is sampled where possible.
- Listeria is often present at low levels compared to other bacteria. So-called rapid methods for the detection of listeria are not always sensitive enough or specific enough and can result in false positive and false negative test results. Analysis methods used should therefore be able to detect *L. monocytogenes*. Using methods to also detect other listeria types is therefore of limited value as these rarely cause disease in humans.

Important practice for the implementation of sampling

Sampling of raw material salmon:

- Sampling must be performed before the raw material comes into direct contact with equipment and machinery in your own plant. For whole salmon, gills and sides are swabbed. For gutted salmon, the abdomen is also swabbed. For raw material fillet, the fillet side is swabbed. Pooled samples from fish from the same batch or supplier can result in savings on analysis costs.

Sampling of equipment and environment:

- During sampling from equipment or the environment after cleaning, cloths or swabs with neutralising buffers should be used to neutralise any residual cleaning agents present in the sampling location. Neutralising buffers should not be used for sampling during production.
- The area that is sampled should be clearly defined for each sampling location and sampled in the same way each time sampled.
- Apply force to cloths/swabs that are repeatedly moved back and forth across the sampling area. Turn the cloth/swab and swab the same sampling location once more but in a different direction to the initial swabbing.
- Avoid cross contamination during sampling. Use sterile gloves and change these between each sampling.

3 Problem-solving: How to get rid of listeria?

It is an undisputed fact that prolonged listeria problems in production environments are associated with cleaning being unable to eliminate the bacteria from machinery, equipment or premises. Nevertheless, cleaning as a tool for combating a chronic listeria problem is rarely adequate.

Wash down/resetting

If cleaning tests (ATP, UV or total viable counts) show unsatisfactory cleaning, it would be appropriate to conduct a thorough deep clean to remove bacteria deposits on equipment and thus reduce the levels of problem bacteria, including listeria. It is important to be aware that deep clean or "resetting" is often not an effective approach for eliminating "in-house" listeria strains.

This guide describes an approach termed "seek-destroy" in the USA. The strategy is based on directing resources to identify listeria sources and subsequently eliminate these. The method is based on experiences from companies where hygienic status is generally good but where listeria problems may still occur due to "in-house" listeria strains in a few locations in the plant.

Before initiating measures to eliminate listeria the source(s) must be identified.

- 1 It is important to establish whether the listeria source is in your own company or if it originates from suppliers.
- 2 It must then be established whether listeria is present on machinery and equipment with contact surfaces to the product or only in the surrounding environment (drains, floors, wheels). This can be investigated using swabs/gauze pad samples after cleaning.
- 3 Sources are identified through star sampling (multiple samples in the area surrounding the positive location) after cleaning.

3.1 Raw materials

The probability of experiencing a listeria problem, with the associated costs and risk, increases in line with the amount of listeria bacteria entering the production environment. Sporadic introduction of listeria through raw materials cannot be avoided. There are differences in the incidence of listeria in gutted salmon from different suppliers. Action must be taken if the control programme identifies that certain suppliers often or always supply salmon with listeria.

- 1 The company should require measures and documentation from the supplier demonstrating that the problem has been solved.
- 2 The company should stop using suppliers who are unable to combat listeria.
- 3 Currently there are no legal and effective methods to decontaminate salmon for the purpose of eliminating listeria.

Raw material suppliers

Suppliers who often or always supply raw materials with listeria most likely have "in-house" strains on machinery or equipment. It is important to be aware of the risk of exposing your own production lines to raw materials carrying listeria strains with especially good ability to become established in production environments.

3.2 Machinery, equipment and premises

The approach should be risk-based. Problem areas that have direct contact surfaces with the product should be prioritised. When the problem in these areas has been removed you can concentrate on other locations.

3.2.1 Eliminating the source of listeria

Niches for listeria are often locations that cannot be kept clean through ordinary cleaning, either because it is hard to access at macro level (conveyor belts under the ceiling, cavities) or micro level (porous materials).

- 1 For listeria-positive conveyors/slicing machines the bacteria may have become established on the actual belt, between mechanical components or in cavities (e.g. inside rollers). It would be difficult or impossible to remove listeria from a worn woven belt and other worn materials made from plastic or rubber using cleaning and disinfection. These parts should therefore be replaced.
- 2 It would therefore be difficult to completely eliminate listeria from tubing, rubber and plastic components. These must be replaced in the event of problems.
- 3 If listeria has become established in a wound or scratch on the floor, in concrete or rust in a drain or on a floor scraper it will not be possible to eliminate listeria through ordinary cleaning. In such cases it would be most appropriate to repair the floor, add steel inserts in the drains or buy a new floor scraper.
- 4 Brushes for footwear can also be difficult to clean and should be replaced, removed or heat-treated if they can withstand heat treatment.

Examples of listeria niches

Coarse materials

- Worn materials with fractures, abrasions or broken seals (e.g. old conveyor belts)
- Corroded surfaces (e.g. in rusted drains and screws)
- Coarse concrete and rubber materials (e.g. drains and floors, gaskets, floor mats)

Poor hygienic design of equipment and premises

- Inaccessible components in machinery and equipment (e.g. slicing machines, gutting machines, RSW systems, conveyors and injection equipment)
- Transitions between metal and rubber
- Welding joints
- Surfaces that do not dry, e.g. floors without a slope towards drains or transitions between floors/walls
- Contamination from unclean areas, e.g. from the environment to contact surfaces (condensation droplets, backward flow from vacuum systems, refrigeration systems)

Poorly adapted for cleaning

- Narrow premises or machines positioned in an inaccessible location

3.2.2 Cleaning and disinfection

With regard to problem areas with "in-house" listeria strains the aim is complete elimination of bacteria. This therefore requires a stronger approach than ordinary cleaning with regard to both cleaning detergents and methods.

The effect of cleaning and disinfection is a function of the chemical composition of agents, duration of action, temperature and mechanical energy:

- 1 If you have a reputable supplier of cleaning detergents you can use the same agents as for ordinary cleaning when eliminating "in-house" strains.
- 2 Switching between agents with different mechanisms of action may increase the probability of succeeding.
- 3 It may be appropriate to increase the concentration and duration of action.
- 4 During open cleaning the mechanical energy and removal of dirt and bacteria are part of the rinsing step and it is important to be aware of the importance of this step. Mechanical energy could alternatively be applied through brushing.

Removal of biofilm

Bacteria and bacterial biofilm in principle comprise fat, carbohydrates and proteins, and special cleaning detergents are not necessary to remove biofilm. The most commonly used cleaning detergent is chloralkali. Chloralkali agents are based on a synergistic effect between high pH (lye) and hypochlorite. Lye is multifunctional and dissolves and breaks down organic material, especially protein and fat. Potassium hydroxide (POH) may be most effective against fatty dirt and sodium hydroxide (NaOH) may be most effective against protein-rich dirt. Potassium hypochlorite oxidises/breaks down organic material. To prevent accumulation of mineral salt deposits it may be appropriate to occasionally use an acidic detergent intended for this purpose. The most commonly used disinfectants are based on surfactants (e.g. quaternary ammonium compounds), peracetic acid or hypochlorite. It is common to switch between agents with different mechanisms of action, e.g. quaternary ammonium compounds and peracetic acid.

Conveyors, slicing machines and similar

Listeria can be eliminated from parts of the machine that are not worn or jointed conveyor belts if the equipment is able to withstand strong cleaning detergents and/or heat. (Contact the supplier if in doubt, a machine that cannot withstand cleaning should not be used for food production).

- 1 Dismantle the machine completely.
- 2 Take samples for listeria in locations with visible dirt/deposits or locations where you believe listeria could be found (e.g. parts that look worn, are often left damp, transitions between materials).
- 3 All visible dirt must be removed, if necessary through scrubbing. Protect the surroundings against potential aerosols from scrubbing or carry out scrubbing in different premises. Consider brushes for this purpose to be single-use only or heat-sterilise them after use.
- 4 Clean using a double dose of chloralkali wash. Rinse off the detergent and check that the components look clean.
- 5 Disinfect using a double dose of disinfectant. The conveyor or parts of the conveyor that can withstand heat can be steam-treated (72°C for a minimum of one hour).
- 6 All components must be cleaned using rubbing alcohol and must be dry before assembly.

During dismantling it is important to look for areas that could collect dirt and provide favourable conditions for new bacteria growth, e.g. cavities that cannot be accessed during cleaning. It may be necessary to adjust the cleaning instructions for the machine based on findings from dismantling and cleaning.

Pipe systems

Pipe systems associated with vacuum (e.g. gutting machines and scrapers) and water (e.g. refrigeration tanks, bleeding tanks and RSW) could be listeria habitats. Experiences from the industry show that the best measure for solving listeria problems and achieving a lasting good hygienic situation is circulation cleaning (CIP) of all pipe systems that come into direct or indirect contact with fish. Alkaline combination agents (65-70°C) and acids intended for CIP are used in the cleaning step, followed by chemical disinfection with the possibility of measuring the concentration (mS). When buying machines with pipe systems it is important, as with all equipment, to set out requirements for

suppliers in respect of cleaning and that it must be possible to verify whether cleaning is adequate and that the cleaning processes can be monitored. When installing CIP in existing machines, the desired effect will not be achieved without optimisation of the system, training and validation. Furthermore, this also requires resources for control, monitoring, reporting and improvement of the process.

In the absence of CIP the same strategy as for conveyors can be used, if practically possible, including complete dismantling, cleaning, disinfection and rubbing alcohol. Some companies have good experience of replacing valves to prevent backflow from the main pipes of the vacuum system to the pipe system for the gutting machine itself.

Drains, floors and floor-related areas

The use of citric acid powder to keep pH down (<5) during the period between cleaning and production could be a relevant measure to reduce listeria on floors. Like other parts of the production premises, drains must be cleaned and disinfected daily. Listeria problems often arise if this is not done.

Cleaning of drains and floors

If listeria is identified on a well-maintained floor or drain after cleaning the question is whether the bacteria originates from other equipment, footwear or floor scrubbers rather than the floor/drain itself. This should be investigated in more detail before applying resources such as scrubbing of floors/drains. This is because scrubbing could, in itself, cause the spread of bacteria. Drains and floors should preferably be cleaned before other equipment and then also be cleaned and disinfected at the end of cleaning. Listeria samples can then be taken to identify whether the drain is a source of infection.

Unfortunately there are few or no documented methods for eliminating listeria from drains when listeria has become established there. If brushing of drains using high concentrations of detergents followed by disinfection is inadequate for eliminating listeria the actual drain would need to be replaced. Floor squeegees and brushes should be sampled and replaced in the event of listeria being detected.

Relevant reports, guides and articles

Title	Source
Guidelines for the application of general principles of food hygiene to the control of <i>Listeria monocytogenes</i> in foods	Codex Alimentarius – CAC/GL 61, 2007 (http://www.codexalimentarius.net/download/standards/10740/CXG_061e.pdf)
Guidance for the Control of <i>Listeria monocytogenes</i> in Ready-to-Eat Foods. Part 1-4	Ministry for Primary Industries, New Zealand, 2011-2012 (http://www.mpi.govt.nz/news-resources/publications)
Control of <i>Listeria</i> in the food production environment	Tompkin RB. Journal of Food Protection 65 (4) 2002
Hygienic equipment design criteria	European Hygienic Engineering and Design Group, 2004 (EHEDG; www.ehedg.org)
<i>Listeria monocytogenes</i> control manual	US Smoked seafood working group, 2002 (http://seafood.oregonstate.edu/.pdf%20Links/Listeria-monocytogenes-Control-Manual-Smoked-Seafood-Working-Group.pdf)
The control and management of <i>Listeria monocytogenes</i> contamination of food	Food Safety Authority of Ireland ,2005 (https://www.google.no/?gfe_rd=cr&ei=Sb_gU8qVL4_K8gea-oDYDQ&gws_rd=ssl#q=The+control+and+management+of+Listeria+monocytogenes+contamination+of+food)
Bedriftspraktiske tiltak for å hemme forekomsten av <i>Listeria</i> i lakseprodukter	Norsk Sjømat no. 1, 2011
Smoked salmon industry practices and their association with <i>Listeria monocytogenes</i>	Rotariu O. et al. Food Control 35 (1), 2014
Recommended international code of practice general principles of food hygiene	Codex Alimentarius – CAC/RCP 1-1969, Rev. 4-2003.
FHL Guide. Personlig hygiene i sjømatbedrifter	Fiskeri- og Havbruksnæringens Landsforening 2012 (http://fhl.no/wp-content/uploads/2014/04/Veil_pershyg_NO.pdf)
Guidance for industry: Control of <i>Listeria monocytogenes</i> in refrigerated or frozen ready-to-eat foods; draft guidance	US Food and Drug Administration, 2008 (http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/FoodProcessingHACCP/ucm073110.htm)
Guidelines on sampling the food processing area and equipment for the detection of <i>Listeria monocytogenes</i>	Carpentier B. and Barre L., 2013 (https://sites.anses.fr/sites/default/files/documents/LIS-Ws-2013S314.pdf)

Glossary including definition of terms

Biofilm: Bacteria and other microorganisms bound to each other and/or a surface. Listeria can form biofilms independently or as part of more complex biofilms together with other microorganisms. Bacteria in biofilms have a substantially increased tolerance against cleaning agents and disinfectants and may be difficult to eliminate through ordinary cleaning.

Direct transmission: Transmission (contamination) through direct contact between the source of infection and the product.

Indirect transmission: Transmission (contamination) without direct contact between the source of infection and the infected product or surface. Examples include transmission from ceilings via condensation droplets or sprays from infected surfaces (e.g. drains, floors) to the product or other surfaces/equipment.

Critical control point: A step that can be controlled and which is crucial for the prevention or elimination of a risk linked to the product's health risk or that can reduce the risk to an acceptable level.

Listeria niche: A term for a limited area in which listeria could potentially grow and survive. In the food industry this will often be areas that provide the bacteria with growth opportunities and protection. Such areas are often difficult to clean. Examples are cracks in conveyor belts, floor mats and plastic vessels, metal-plastic transitions, corroded screws, welding joints, pipe systems and generally machines and equipment with a poor hygienic design.

Risk: A measure combining the probability and effect of an event. This is described as a function: Risk = probability x consequence. In production environments there are areas with high and low probability of being listeria niches and the consequences of listeria becoming established in these niches are greater if the niche is a product contact surface. The total risk is assessed through risk-based monitoring, preventative work and prioritisation of measures. In the salmon industry, incidents with low probability, e.g. listeria in the packaging machine for smoked salmon could be associated with a high risk if the consequence would be that listeria could easily infect the product. On the other hand, incidents with a high probability, e.g. listeria in drains, could be associated with a low risk if the consequence of listeria in the drain is low (e.g. the drain is situated far away from production lines and products).

Risk profiling: Profiling in order to gain an overview of risks in a systematic manner. Used here to identify and rank factors in the plant (production conditions, procedures, listeria niches) by risk of listeria

Risk-based sampling: Method for the planning and implementation of sampling in plants, based on risk. Based on risk profiling, sampling of areas with the greatest risk of causing listeria in the final product will be prioritised. Sampling for listeria in the salmon industry should be risk-based.

Source of infection: Designates sources of listeria that result in transmission to the plant and products.

Trend analysis: Registration, review and analysis of sampling data over a specific period of time. This should be performed regularly to identify trends, changes and the need for corrective actions for control of listeria.

