



Processed Meats Code of Practice

Part 3: GMP – Process Control

Prelims

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Website

A copy of this document can be found at: <http://www.nzfsa.govt.nz/animalproducts/index.htm>

Review of Code of Practice

This Code of Practice will be reviewed, as necessary, by the New Zealand Food Safety Authority. Suggestions for alterations, deletions or additions to this code of practice, should be sent, together with reasons for the change, any relevant data and contact details of the person making the suggestion, to:

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1 Introduction

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1.1 Purpose and Scope

This Code of Practice (COP) has been developed by the New Zealand Food Safety Authority (NZFSA) and the Pork Processors Association to assist meat processors comply with the requirements of the Food Act 1981 and the Animal Products Act 1999 (APA), and produce processed meats that are safe and suitable for their intended purpose.

This COP has been written for processors of processed meats, including smallgoods, operating a Food Safety Programme (FSP) under the Food Act, or a Risk Management Programme (RMP) under the APA. However, the guidance provided is also recommended for those operating under the Food Hygiene Regulations 1974.

Parts 2 and 3 provide guidance on Good Manufacturing Practice (GMP). Part 2 covers hygiene and sanitation, and quality assurance programmes. Part 3 focuses on process control at key processing steps. Processors should comply with both parts to ensure the safe production of processed meats. Examples of processed meat products covered by this COP are:

- fresh sausages
- cooked comminuted meat products (e.g. luncheon, bologna, cooked sausages)
- uncooked comminuted fermented meat products (UCFM) (e.g. salami, pepperoni)
- cooked cured meat products (e.g. ham, corned beef, pastrami)
- cooked uncured meat products (e.g. roast beef)
- bacon
- dry-cured meat products (e.g. prosciutto)
- dried meat products (e.g. jerky, biltong)
- meat patties.

1.2 Contents of Part 3

Section 2 of this part gives the general requirements, including regulatory requirements that apply to all products and processes covered in this COP. Sections 3 to 9 discuss the specific requirements and procedures for the process steps commonly used in the production of processed meats.

The procedures given in each section are the accepted or industry agreed means of achieving or complying with regulatory requirements. These procedures cover control, monitoring, corrective action, and verification. The operator must comply with the procedures that are applicable to their product and process unless they have proposed an alternative process, procedure or parameter that is not provided for in this COP. The operator must demonstrate the validity and effectiveness of any proposed alternative. Any alternative process, procedure or parameter must be documented in the FSP or RMP, and be approved by the NZFSA (through registration of the RMP or a significant amendment to an RMP, or approval of the FSP).

Guidance material is presented in a box. It provides explanatory information, recommendations and options for achieving a particular requirement.

1.3 Definitions

Cooling medium - any solid, liquid or gaseous medium that is introduced and comes in contact with wrapped or unwrapped product with the objective of removing heat.

Cooking - the application of heat to a product to destroy vegetative pathogens that may pose a hazard to human health.

Comminution - process of reducing meat or meat product in size by methods such as mincing, flaking, slicing, dicing, but does not include mechanical separation.

Control measure - any action and activity that can be used to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Corrective action - any action to be taken when the results of monitoring a process step or control measure indicate a loss of control.

Critical Control Point (CCP) - a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Critical limit - a criterion which separates acceptability from unacceptability at a CCP.

Lethality - measure of the ability of a process to destroy a particular pathogen.

Food additive - any substance not normally consumed as a food in itself and not normally used as an ingredient of food, but which is intentionally added to a food to achieve one or more technological functions.

Food Standards Code - the code incorporated into New Zealand law by the New Zealand (Australia New Zealand Food Standards Code) Food Standards 2002 and issued by the Minister under section 11C of the Food Act 1981.

HACCP (Hazard Analysis and Critical Control Point) - a system that identifies, evaluates and controls hazards that are significant for food safety.

Manufactured meat - processed meat containing no less than 660g/kg of meat.

Minimise - to have taken all practical steps to substantially reduce the potential hazard of concern, consistent with what is technologically feasible.

Monitor - the act of conducting a planned sequence of observations or measurements of control parameters to assess whether a process step or control measure is under control.

Operator-defined limit - a measurable limit established by an operator to manage the fitness for purpose of a particular product.

Pathogen - a microorganism which causes illness.

Post-processing - process steps or activities undertaken after the application of a lethal heat or preservation treatment such as cooking, fermentation, or drying.

Process control - all conditions and measures applied during the production process that are necessary to produce a safe and suitable product.

Processing areas/rooms - include all areas where raw materials and ingredients are prepared (e.g. thawed, cut, weighed, pre-mixed, injected, cured, massaged, tumbled, emulsified, filled), processed (e.g. cooked, cooled, dried, fermented, sliced), and packed.

Processed meat - a meat product containing no less than 300 g/kg meat, where meat either singly or in combination with other ingredients or additives, has undergone a method of processing other than boning, slicing, dicing, mincing or freezing, and includes manufactured meat and cured and/or dried meat flesh in whole cuts or pieces.

Ready-to-eat (RTE) product - product that is ordinarily consumed in the same state as that for which it is sold. RTE products do not require additional preparation to achieve food safety, however, they may receive additional preparation for organoleptic reasons (i.e. to make them taste and/or look better). They can include frozen processed meat products.

Regulatory limit - a measurable regulatory requirement that is critical to the fitness for intended purpose of a particular product.

Rework (noun) - product which has been partially or fully processed and is incorporated and reprocessed into another batch of product.

Rework (verb) - to incorporate rework into another batch of product.

Separate by distance - to separate products or processes by location or distance within a room or area so that any contact or contamination between products, equipment, processes or personnel is avoided.

Separate physically - means to separate by floor to ceiling walls and doors, or to fully protect product by containing it in enclosed pipelines, vats, etc.

Separate by time - to separate products and processes by means of a time difference.

Smallgoods - term commonly used in New Zealand to refer to manufactured meat products such as hams, bacons, other cured products, and cooked meats.

Spoilage microorganism - microorganisms which cause deterioration of food and limit the shelf-life of foods by producing objectionable flavours, odours and slime.

Suitably skilled person - a person who in the opinion of the operator is skilled in a particular activity or task through training, experience, or qualifications.

Tempering - in the case of frozen product, tempering means the elevation of the temperature to any point that is lower than the freezing point of the product. (Meat begins to freeze at about -2°C).

Thawing - the elevation of the temperature of frozen product to temperatures that are higher than the freezing point of the product.

Validation - process of obtaining evidence to demonstrate that a particular product will be fit for intended purpose, through the achievement of any regulatory limit or operator-defined limit.

Verification - the application of methods, procedures, tests and other checks to confirm compliance to the documented Food Safety Programme or Risk Management Programme, and legislative requirements.

Water activity (a_w) - a measure of the water in the food which is available for microbial growth. It is the ratio of the water vapour pressure of the food (p) to that of pure water (p_o) at the same temperature, $a_w = p/p_o$.

2 General Requirements

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2.1 Scope

This section gives the regulatory requirements and other industry agreed requirements that apply to all products and processes covered in this COP.

To identify a regulatory requirement, the legislation from which the particular requirement is taken is cited at the end of the sentence. In most cases, the mandatory requirements have been paraphrased. Operators should refer to the legislation for the actual wording. Legal requirements from the APA are mandatory for businesses operating under an RMP, and they are strongly recommended for those operating under an FSP. The abbreviations used for legislation cited are:

- AP Reg - the current version of the [Animal Product Regulations](#)
- HC Spec - the current version of the [Animal Products \(Specifications for Products Intended for Human Consumption\) Notice](#)
- RMP Spec - the current version of the [Animal Products \(Risk Management Programme Specifications\) Notice](#)
- AC Spec - the current version of the [Animal Products \(Specifications for Products Intended for Animal Consumption\) Notice](#)
- FSC - the current version of the [Food Standards Code](#)

2.2 Regulatory Standards

The operator must meet all relevant product and processing requirements set out in the Food Standards Code, the Food Act and the APA, including but not limited to the following:

- a. meat and meat product standards (FSC Standard 2.2.1)
- b. substances added to food, e.g. additives and processing aids (FSC Part 1.3)

- c. microbiological limits ([FSC Standard 1.6.1](#))
- d. processing standards (e.g. [UCFM Standard](#))
- e. labelling and other information requirements (FSC Part 1.2)

2.3 Hygienic Practices

2.3.1 Operators must establish and carry out procedures to:

- a. ensure appropriate and adequate maintenance, cleaning, and sanitation of premises, facilities, essential services, and equipment
- b. manage waste
- c. control pests; and
- d. implement effective personnel hygiene practices. **[AP Reg 11; Food Act Section 8G]**

Refer to Part 2 for requirements and procedures for hygiene and sanitation.

2.3.2 All inputs, including raw materials, ingredients, additives and packaging must be handled, processed, and stored in a manner that minimises any potential contamination or deterioration. **[AP Reg 9, HC Spec 115]**

2.3.3 Rooms used for the processing of meat products must be operated in such a manner that minimises the growth of microorganisms likely to affect human health. **[HC Spec 114(1)]**

Processing areas should be maintained at a temperature not exceeding 12°C, except when:

- a. temperature conditions are sufficient to maintain the temperature of the meat and/or mix at not more than 7°C; and/or
- b. processing areas are used for thermal processing or fermentation, or where a higher temperature is either not detrimental to product safety or is required for its manufacture.

If the raw meat processing areas are operating at ambient temperatures, equipment and other product contact surfaces located in this area may require more frequent cleaning. The frequency of cleaning must be justified by the operator (refer to Part 2, section 7.2.4.10).

2.3.4 All steps in the process must be performed without unnecessary delay, and under conditions which will prevent or minimise contamination, deterioration, and growth of pathogenic and spoilage microorganisms in the product.

2.3.5 There must be effective separation to prevent cross-contamination between raw and cooked or ready-to-eat products, or cured and uncured products, or products of different allergen status.

2.4 Documentation and Records

2.4.1 Operators must document any regulatory limit and/or operator-defined limit relevant to their product or process. **[RMP Spec 7 and 11]**

Regulatory and operator-defined limits are measurable limits that are critical to the fitness for intended purpose of a particular product, and must be consistently met for food safety. Regulatory limits are defined by the regulator, whereas operator-defined limits are established by the operator.

These limits may be expressed as a:

- a. product requirement (e.g. microbiological limit, pH, a_w)
- b. process parameter (e.g. minimum cooking time-temperature combination); or
- c. performance criteria (e.g. 6D reduction in *Listeria monocytogenes*).

Regulatory limits are specified in legislation (e.g. Food Standards Code, HC Spec). When no regulatory limit is specified and when necessary for food safety, the operator is expected to define and justify their own limits. Operator-defined limits may be taken from sources such as reputable codes of practice, peer-reviewed scientific information, predictive models, scientific information from a person or organisation known to be competent, or developed from the operator's own trials and experiments.

2.4.2 Operators must document the following in their FSP or RMP:

- a. processing procedures, and product and process parameters
- b. procedures for monitoring and verifying compliance to established processing procedures and parameters, particularly critical limits at identified critical control points

- c. corrective actions for any non-compliance or deviation to any regulatory limit or operator-defined limit, procedures, and product and process parameters. **[RMP Spec 8 and 11; Food Act Section 8G]**

- 2.4.3 Operators must maintain accurate records, particularly those for the monitoring and verification of product and process parameters critical to food safety. **[RMP Spec 20(2); Food Act Section 8G]**

Refer to Part 2, Section 3: Documentation and Record Keeping.

2.5 Product Formulations

- 2.5.1 Product formulations must be developed by a suitably skilled person, and be documented.

The suitably skilled person should have technical skills and experience in developing formulations, be familiar with permitted levels of ingredients and additives, and understand the effect of any change in the formulation on product characteristics, allergen status of the product, process parameters, labelling, etc.

- 2.5.2 A suitably skilled person must assess the effect of any change in a product formulation on any regulatory or operator-defined limits and/or processing parameters, and ensure that any consequential changes in processing are made before the new formulation is used commercially.

For example, a different proportion of meat and cereals in emulsion sausage formulations may require changing the cooking cycle.

- 2.5.3 Product formulations must be properly adjusted to account for the addition of any rework. The operator must establish a limit for the amount of rework which can be added to a batch since this can affect its functionality and the additive levels (e.g. nitrite) in the finished product.

- 2.5.4 Product formulations must result in additive levels in the finished product that comply with any permitted levels specified in the [Food Standards Code, Standard 1.3.1.](#)

2.5.5 The operator must be able to provide evidence that additive levels in finished products comply with permitted levels in the Food Standards Code.

Operators are not required to routinely test all batches of products against these criteria, but it is recommended that samples of products are occasionally tested as part of the verification programme.

2.6 Traceability

The operator must document and implement a tracking system that:

- a. allows for the identification of all raw materials, ingredients, products, and packaging (when appropriate); and
- b. enables the movement of raw materials and ingredients to be traced from the supplier; and to the next person or company that any product is transferred to for further processing, packing, storage, distribution or sale. **[AP Reg 18(1)(b)(i)]**

Refer to Part 2, Section 16: Traceability and Inventory Control.

3 Preparation Steps

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3.1 Scope

This section covers the process steps commonly undertaken in the preparation of processed meats before the application of a heat or preservation treatment such as cooking, fermentation, or drying.

3.2 Tempering and Thawing

3.2.1 General procedures

3.2.1.1 Tempering or thawing of frozen meat must be done in a manner, and under conditions, that minimise contamination of the meat and the growth of microorganisms.

3.2.1.2 Tempering and thawing procedures and parameters (e.g. time and temperature) must be documented in the FSP or RMP.

3.2.1.3 Any equipment used for the tempering or thawing of meat (e.g. microwave) must be operated according to the manufacturer's instructions.

3.2.1.4 Thawed meat must be processed without unnecessary delay, or it must be held under refrigeration while waiting to be further processed.

Frozen meat cuts should be thawed throughout the cut. Improperly thawed meat could cause insufficient cure penetration or failure to reach a required cooking temperature.

When the temperature of any part of the product during thawing exceeds 10°C, the temperature should be reduced to less than 7°C within a period of time calculated as the thawing lag time at the warmest temperature recorded for the process according to the following formula (Lowry *et. al*, 1988): $y = 0.00185x^2 - 0.136x + 2.841$

where x = the temperature of the product in °C, and y = log lag time in hours.

3.2.1.5 Procedures for the removal of plastic liners entrapped in the meat must be established and documented.

The occurrence of entrapped plastic in the meat may be reduced by using thicker gauge liners which are less likely to tear, and using blue liners which are easier to see.

3.2.2 Tempering and thawing in air

3.2.2.1 Carcasses or cartons must be spaced apart to allow good air circulation.

3.2.2.2 Thawing must not result in contamination of other products with thaw drip.

1. Frozen cartoned meat may be thawed at:

- a. a maximum air temperature of 10°C for 72 hours; or
- b. a maximum air temperature of 7°C for 96 hours; or
- c. a maximum air temperature of 15°C provided: no part of any product exceeds 7°C, the temperature of the product is constantly monitored, and the whole thawing process is under an automatic control system. The temperature of the product at the top leading corner of the carton (i.e. the corner that first intercepts the air flow, at the warmest location in the chiller) should be used as the reference to monitor and control the temperature.

2. A two-stage thawing cycle has been suggested by MIRINZ as an alternative thawing regime which results in faster thawing without causing unsafe high temperatures at the centre of the top surface (Fleming, 1989).

Their study showed that higher air temperatures in the early stages of the thawing cycle can be tolerated without compromising meat hygiene because pathogenic bacterial growth is impeded after a freeze/thaw cycle by an unusually long “lag phase” when no growth takes place. The combination of cold surface temperature and long lag phase can allow meat to be subjected to warm air for a short period at the start of the thawing process, to reduce the thawing time required. For example, a standard 27 kg carton of boneless beef, which would take 3 days to thaw in air held at 10°C, will take only 2 days to thaw if air temperature is held at 20°C for the first 16 hours and then lowered to 10°C.

A thawing regime based on this concept may be proposed by the operator provided that it is validated.

3. Frozen meat for grinding or slicing is usually tempered to about -5 to -2°C. In 'warm air' (10°C or higher), it is difficult to get even tempering of frozen meat to a uniform temperature. The meat surface may be completely thawed and soft while the centre of the meat blocks remains frozen. Tempering to a uniform temperature requires an air temperature either at, or just above, the desired meat temperature (e.g. tempering at 0°C chiller). Under such conditions, tempering of large blocks of cartoned meat may take several days to complete.

3.2.3 Thawing in water

3.2.3.1 Fresh potable water must be used for each thawing cycle.

3.2.3.2 Thawing must be carried out at a temperature that minimises the growth of microorganisms and allows the product to thaw within the desired thawing period.

The temperature of the thawing water should not exceed 10°C. A higher thawing temperature (e.g. up to 15°C) may be considered provided the operator can demonstrate that it will not result in unacceptable microbiological growth considering the holding time at the particular temperature, and any subsequent steps which may inhibit microbiological growth. For example, a higher temperature may be justifiable if the meat is injected or immersed in cold brine soon after thawing.

3.2.3.3 The thawing tank must not be overloaded with product. There must be adequate space to allow effective circulation of the thawing water around each product item.

Good water circulation is essential for efficient thawing. A system for circulating water evenly around the tank helps avoid large temperature gradients and uneven thawing throughout the tank.

3.2.3.4 The thawing tank must be emptied, cleaned and sanitised after each thawing cycle (i.e. after thawing a batch of meat).

3.2.4 Other tempering or thawing methods

Operators may use other tempering and thawing methods (e.g. microwave thawing) provided that the outcomes given in section 3.2.1 can be met, and evidence is provided to demonstrate this.

3.3 Cutting, Boning and Trimming

3.3.1 Carcasses, sides and quarters must be checked for visible defects prior to the start of cutting and boning, and any defect found must be removed in a hygienic manner.

Visible defects include rail dust, grease, bruises, lesions, blood clots, clusters of hair, dirt or other extraneous material.

3.3.2 Defective material and contaminated meat (e.g. dropped meat) must be immediately disposed of to waste bins or containers for animal consumption materials, as appropriate.

3.3.3 Different species of meat must be processed separately (i.e. on different tables or at different times) unless the finished product includes a mixture of those species.

3.3.4 The operation must be managed so carcasses and cuts are maintained at a temperature that prevents microbial growth during cutting and boning, or trimming.

Meat temperature should be maintained at $\leq 7^{\circ}\text{C}$ during and after cutting and boning. The operator should establish how many carcasses, sides or quarters should be taken out of the chiller at a time in order to maintain the correct temperature and minimise exposure of the meat. Cuts and trimmings should not be allowed to accumulate. Unless they are to be used immediately, they should be periodically transferred to a chiller or freezer during the working period.

3.4 Comminution

3.4.1 Comminution must be done in a manner that minimises contamination and growth of microorganisms in the product.

3.4.2 Procedures for preventing metal contamination from grinders and flakers, and corrective actions when metal contamination occurs must be established and documented.

Grinders and flakers should be checked and maintained regularly to prevent metal contamination from equipment. Some companies also have procedures for preventing metal contamination from newly installed blades. For example, when a new or resharpened blade is installed, the first few kilograms of mince produced after installation is dumped to waste.

3.4.3 Comminuted meat must be further processed without unnecessary delay, or it must be held under refrigeration while waiting to be further processed.

When grinding or flaking frozen or tempered meat, the latent heat of melting limits temperature increase during comminution. However, grinding of chilled or thawed meat can lead to an increase in temperature to as high as 10°C. If the meat is not going to be used immediately after comminution, it should be refrigerated so that its temperature is reduced and/or maintained at ≤ 7°C while waiting to be further processed.

3.4.4 Grinders, flakers and other equipment must be maintained in a hygienic condition during the production period.

Grinders, flakers and other equipment that are used intermittently during the day, and/or located in non-refrigerated rooms, may need to be cleaned more frequently to minimise the build-up of microorganisms on the equipment which may contaminate subsequent batches of meat.

Equipment which has been used but is temporarily idle should be cleaned before re-use if the delay is in excess of 4 hours. More frequent cleaning may be necessary if the equipment is located in a non-refrigerated room.

Material left in “dead spots” of the grinder are likely to have high microbial counts. Therefore, residual meat in the screw and plates which are removed during disassembly of the grinder (i.e. at the end of the each working day, and every time the grinder is cleaned after standing idle for a long period) should be discarded.

3.5 Weighing and Assembly of Ingredients

3.5.1 General procedures for weighing of ingredients

3.5.1.1 Correct formulations or recipes must be available to, and used by, the person responsible for weighing ingredients.

3.5.1.2 The weighing and assembly of ingredients and additives must be carried out only by designated and trained personnel.

3.5.1.3 Accurate scales with appropriate capability must be used for weighing ingredients and additives.

For example, a 5 g amount should not be weighed on a 25 kg scale having 100 g graduations.

Weighing scales should be checked daily against test weights. Refer to Part 2, Section 10: Calibration of Measuring Devices.

All ingredients should be measured by weight so a single standard unit of measure is used for formulations. Uncalibrated or non-standard containers (e.g. drinking mugs or cups, or buckets) should not be used for measuring since they give inaccurate measurements and mistakes can easily happen when the container is changed.

3.5.1.4 The identity of ingredients and additives used, and their amounts, must be recorded (e.g. in a checklist).

Restricted additives, such as nitrite, should be kept in a locked container or facility. The amount of nitrite used should be regularly reconciled (e.g. weekly) against the amount held in storage.

Nitrite can be toxic to consumers at excessive levels and its addition to the product should be controlled. The use of pre-blended curing mixtures (i.e. nitrite mixed with salt and other ingredients, and which are usually tinted pink) prevents the addition of excessive amounts of nitrite into the product. When pure nitrite is used, it is possible that the person weighing the ingredients might confuse the quantity required with that of salt and mistakenly add excessive amounts of nitrite.

3.5.1.5 The weighing procedures must facilitate the traceability of ingredients used in all batches of products.

3.5.1.6 Containers and utensils used for weighing must be dedicated for the purpose. They must be clean and not be a source of contamination.

3.5.1.7 Dedicated containers and utensils must be used for ingredients containing allergens.

Containers and utensils used for weighing should be clearly identified (e.g. by colour or label).

3.5.1.8 Handling and weighing of allergenic ingredients must be done in way that minimises the potential for cross-contamination of allergens.

Refer to Part 2, Section 14: Allergen Management.

3.5.2 Pre-weighing and assembly of ingredients (i.e. batching)

3.5.2.1 Pre-weighing and assembly of dry ingredients must be performed in a dry ingredient room, or in an area specifically designated for dry ingredient preparation and/or storage.

Some companies have one or two designated workers who are trained in batching ingredients. To minimise mistakes during weighing, they should not leave the weighing area or be interrupted until a batch is completed.

3.5.2.2 Procedures for managing foreign matter from ingredients must be established and documented.

Ingredients with a history of foreign matter contamination should be sieved before weighing. Other ingredients should be randomly checked for the presence of foreign matter.

Findings of foreign matter should be recorded and the object, bagged and labelled with the product details (e.g. name, product code, batch code/ID, production date). Appropriate action should be taken by the operator to prevent re-occurrence (e.g. notify the supplier).

Processors should ensure that they and their ingredient suppliers do not use staples or metal clips for sealing ingredient bags, as they can easily get into the product. The use of string for tying ingredient bags is also a potential source of foreign matter, and should be avoided.

3.6 Preparation of Curing Brines

3.6.1 The weighing of ingredients and additives must be done in accordance with the procedures given in section 3.5.

To prevent mistakes in the use of nitrite, only one bag of pre-weighed nitrite should be present in the preparation area at a time.

Before adding whole cartons or whole bags of an ingredient, such as salt or phosphate, the weights should be checked. A bag of salt or phosphate may not necessarily weigh exactly the net weight declared on the bag.

If the amount of water used is determined by filling the brine tank to a certain level, the tank should be properly calibrated and marked.

3.6.2 Potable water and ice must be used for preparing the curing brine.

3.6.3 The curing brine must be maintained cold.

Curing brine should be maintained at $\leq 5^{\circ}\text{C}$ to minimise nitrite and ascorbate depletion.

3.6.4 Unused curing brine remaining at the end of a day's operation must be kept in the chiller. It must be checked for salt and nitrite content, and adjusted to the required level before being used.

Guidance on the preparation of curing brines (Sadler, 1987):

- a. Batches of brine should be formulated to be as small as possible to prevent leftover solution, while still being economical to the process operation.
- b. Water for preparing the brine should be as cold as possible – preferably near 4°C . Warm water causes nitrite depletion. If ice is used in the preparation of the brine, its weight must be included in the calculations.
- c. Ingredients should be mixed in the following order to permit complete solution and to protect the nitrite and ascorbate: (i) water, (ii) phosphates, (iii) salt, sugar, dextrose and flavourings, (iv) nitrite, (v) ascorbate.
If phosphates are first dissolved in a small quantity of warm water prior to adding to the curing tank, the quantity of warm water must be included in the total weight of the brine.
- d. Brines should be monitored using an accurate working salinometer. The influence of phosphates on a salinometer reading may be 10-12%; this influence must be corrected for. When possible, in addition to a salinometer reading, laboratory analysis of brines is also recommended.
- e. Brines should be maintained constantly, cold and temperature changes should be avoided. Any increase in temperature causes nitrite depletion. Curing brines should be continuously held at about 5°C . Keeping brines cold not only retards nitrite depletion but also increases product yield.
- f. Excess or severe agitation of the brine by steam, air or mechanical means causes nitrite depletion and should be avoided.

- g. Brine transfer lines should not be exposed to warm temperatures. Brines held in a pump line at 26.7°C will undergo nitrite and ascorbate breakdown.

3.7 Curing

The common methods of curing whole muscle meat products are: injection, immersion and dry curing, or a combination of these methods. For example, ham or bacon may be injected with a curing brine, tumbled, and then equilibrated under cover brine for one to two days.

3.7.1 Injection curing

3.7.1.1 The person responsible for operating the injector must check and ensure that the injector needles are in good working condition (i.e. no breakage, not bent or blunt, no blockage) before the start of injection.

3.7.1.2 The injector must be set to consistently deliver the curing brine at the required injection rate.

Correct delivery of curing brine should be determined by measuring the green weight (uninjected) and injected weight of several samples per batch, and adjusting the machine setting until the correct injection rate is achieved.

3.7.1.3 Used curing brine must not be recirculated back to the fresh brine tank.

3.7.1.4 Used curing brine must be discarded at the end of each day's operation. An alternative may be proposed by the operator provided the procedure is validated and can be shown to be microbiologically acceptable. The used curing brine must be checked for salt and nitrite content, and adjusted to the required level before being used.

Fresh brines are likely to carry a microflora of between 100-1000 organisms/ml (Lowry, 1987). Generally, the microbial loading of recirculating brines is approximately ten-fold higher than that of fresh brine. The microflora of such brines is primarily made up of organisms of low spoilage potential, and contains some of high spoilage potential for vacuum packaged product, notably lactic acid bacteria and enterococci. These latter species are present in extremely low numbers in fresh brines, but characteristically increase up to 100-fold over a period of recirculation. The use of highly contaminated brines will, therefore, lead to reduced product shelf-life.

The practice of batch processing (i.e. matching volume of brine with product volume) increases the numbers of contaminating organisms as the volume of the recirculating brine decreases. Because the brine volume is constantly decreasing during processing, microorganism washed off the last product processed are suspended in up to 10 times less brine than is the case for the first product. One way of overcoming this problem is to regularly top up the recirculating brine with fresh brine when the level falls to half-full. In this way, the maximum concentration effect that could result would only be two-fold.

3.7.1.5 The injector must be maintained in a hygienic condition during processing, and must be cleaned and sanitised at least daily.

Sanitation of multi-needle injection machines is very important. Even traces of meat tissue left in the machine at the end of processing can give rise to significant contamination of the brine. Organisms introduced into the brine through poor sanitation and cleaning of equipment are normally those of high spoilage potential. Therefore, cleanliness is critical in assuring optimum shelf-life for products.

Injection machines that are used intermittently during the day may need to be cleaned more frequently (e.g. between batches) to minimise the build-up of microorganisms on the equipment which may contaminate subsequent batches of meat.

3.7.2 Immersion curing

3.7.2.1 Curing procedures and conditions must minimise the growth of pathogenic and spoilage microorganisms, and facilitate uniform curing.

Meat pieces should be uniform in size, and periodic mixing of the batch may be necessary to ensure uniform cure penetration.

The curing brine should be maintained at $\leq 5^{\circ}\text{C}$.

3.7.2.2 The meat must be completely immersed in the brine during curing.

3.7.2.3 As a minimum, curing tanks must be emptied and cleaned between batches.

Re-use of cover brines is not recommended because all ingredients in it are diluted during curing. It will also contain extracted components from the meat, large numbers of salt-tolerant bacteria, and probably some bacterial pathogens.

If cover brines are re-used, the processor should establish how long it should be kept, and the procedures (e.g. temperature control) for ensuring that it remains in an acceptable condition. The quality of the cover brine should be periodically checked (e.g. turbidity, salt level, colour), and the salt and nitrite levels adjusted before being re-used.

After about two to three weeks, depending on the temperature, harmless bacteria in cover brines are gradually replaced by pathogenic bacteria (Sadler, 1987). Therefore, it is recommended that curing brines not be kept longer than this period, and if there is an adverse change (e.g. milkiness, off-odour), the brine should be discarded earlier.

Generally, cover brines can be expected to have microbial loads of $1-6 \times 10^6$ cfu/ml (Wilkinson, 1989). Brines with microbial loads greater than this will give poor quality products.

3.7.3 Dry curing

These requirements apply to the dry curing of bacon and ready-to-eat dried meats such as prosciutto. Additional requirements for ready-to-eat dry-cured meats are given in Section 6: Drying.

3.7.3.1 The meat must be salted and cured under conditions that minimise contamination, inhibit the growth of pathogenic and spoilage microorganisms, and facilitate uniform curing.

3.7.3.2 The correct amount of salt must be used and it must be evenly distributed on all exposed surfaces of the meat.

3.7.3.3 During curing, the temperature of the meat must be low enough to avoid spoilage and growth of pathogens while the ingredients equilibrate across the piece.

Pathogens present on the raw meat (e.g. salt tolerant *S. aureus*) could grow if salt is not evenly distributed or is added at too low a level.

Meat pieces should be uniform in size to facilitate uniform curing. The meat should be rotated and all surfaces of meat should be rubbed with the dry cure mixture at intervals of sufficient frequency to ensure cure penetration.

The temperature of the product should be controlled between 2°C and 7°C during dry curing of muscle cuts (FDA 2001, Food Code Annex 6). The lower temperature is set to limit microbial growth and the upper temperature is set for the purpose of ensuring cure penetration.

3.8 Tumbling and Massaging

3.8.1 The meat must be loaded into, and unloaded from, the tumbler or massager in a hygienic manner.

3.8.2 The tumbling and massaging conditions (e.g. temperature and time) must minimise the growth of microorganisms.

Depending on the product, machine and rotating speed, tumbling and massaging may be done for a short period (e.g. 30-45 min), or it may be done intermittently for longer periods (e.g. 15-20 min activity out of each hour, for 18 hours). Temperature control is important particularly for products that undergo long tumbling/massaging times.

3.8.3 Tumblers and massagers must be maintained in a hygienic condition.

Tumblers and massagers should be cleaned at least daily; or after each cycle, if tumbling or massaging takes more than 24 hours.

3.9 Bowl Chopping and Mixing

3.9.1 Correct formulations or recipes must be available to, and used by, the person responsible for bowl chopping or mixing.

3.9.2 The identity of ingredients and additives used, and their amounts, must be recorded (e.g. in a checklist).

3.9.3 Packaging or containers of pre-weighed ingredients or premixes must be handled and disposed of properly so that they do not become a source of physical hazard or foreign matter (e.g. plastic bag, pieces of paper, string).

3.9.4 The temperature of the meat mixture during chopping must be controlled.

The required cutting temperature varies for different types of products. For cooked sausage products, chopping temperatures of 14°C allow for the desired product appearance and maximum extraction of the binding proteins. Other sausages, such as bierstick and chorizo, are cut or mixed at lower temperatures (e.g. 4°C). Temperatures greater than 15°C to 20°C can result in emulsion

breakdown (Baumgartner, 1987).

3.9.5 The mixture or emulsion must be used (i.e. filled into casings) without unnecessary delay, or it must be held under refrigeration while waiting to be further processed.

3.9.6 The incorporation of rework into any product must be in accordance with the procedures given in section 3.11.

3.9.7 Procedures for preventing metal contamination from bowl choppers and mixers, and corrective actions when metal contamination occurs must be established and documented.

3.10 Filling, Stuffing and Pressing

3.10.1 The meat mixture or emulsion must be hygienically filled into food grade casings, nets or moulds.

3.10.2 Potable water must be used for pre-soaking casings, and the water must be changed regularly.

3.10.3 The filling machine must be adjusted properly to achieve portioning accuracy and evacuation of air pockets from the product. Casings must be filled to the correct diameter.

Under-filling and over-filling can affect the quality of the end product. Diameter size influences the rate of cooking, drying and smoking, and ultimately the flavour and texture of the finished product.

3.10.4 Procedures for preventing the mixing of products from one batch to the next must be established and documented.

The filler should be cleaned between different products (e.g. when products have different allergen status); or the mixture from one batch should be completely purged from the filler before filling the next batch.

3.10.5 Procedures for preventing contamination from metal clips must be established and documented.

3.10.6 Presses or moulds must be regularly checked for rough or sharp edges which can puncture the casing.

3.11 Rework

Examples of product used as rework are:

- a. products that do not meet quality specifications (e.g. broken pieces, leakers, misshapen pieces, and discoloured products)
- b. ends of meat pieces; and
- c. products that do not meet the required heat treatment.

3.11.1 Rework must be handled and stored in a manner and under conditions that minimise contamination and growth of microorganisms.

3.11.2 Rework must be clearly identified and kept separate from other products during storage.

3.11.3 Formulations must be properly adjusted to account for the addition of any rework. The operator must establish a limit for the amount of rework which can be added to a batch since this can affect its functionality and the additive levels (e.g. nitrite) in the finished product.

Because the protein in rework has been denatured, rework has no water or fat binding ability. Therefore, the incorporation of large amounts of rework could have a destabilising effect on the new product. The amount of rework added to a batch should not exceed 5% of the total weight of batch (Rust, 1996).

The use of rework could also have a diluting effect on the functionality of additives, such as nitrite, phosphates or ascorbates in the new batch of product, since all these have reacted with the appropriate components of the original formulation and therefore have little if any residual functionality.

3.11.4 The person responsible for developing and adjusting formulations must also consider any potential effect of using rework on labelling, shelf-life and allergen status, and the introduction of hazards.

Maintaining the acceptable microbiological condition of rework can be difficult due to the extra handling that rework undergoes. Therefore, rework can potentially increase the microbial load of the batch it is added to. The microbiological condition of rework becomes even more significant in dry or semi-dry product (e.g. salami) where no cooking step is applied, thus, more rigid control is necessary for rework used in this type of product (i.e. when manufacturing UCFM, only product that has been through the complete validated process may be reworked back into new product). For this reason, some processors only use rework in cooked products.

Processors should establish a cut-off period for reworking products from one batch to the next to facilitate traceability and recall procedures; and prevent the potential build-up of microbiological resistance against certain inactivation treatments (e.g. cooking).

Recycling of rework through the system for prolonged periods has the potential to cultivate strains of unwanted microorganisms that may be very difficult to destroy with normal cooking cycles (i.e. recycling inadvertently selects for heat resistant strains of certain organisms) (Rust, 1996).

Therefore, the operator should periodically clear out all rework. For example, some manufacturers have a weekly cut-off (i.e. material produced in a previous week is not reworked into the current week's production).

3.11.5 Any material or product, whether in stock or returned, which may have been mishandled or exposed to contamination must not be reworked into new product.

3.11.6 Procedures for tracing the batches of reworked materials and the batches of products they have been used in must be established and documented.

3.12 Metal Detection

3.12.1 Metal detectors must have the appropriate sensitivity for the type and size of metal identified as a hazard in the particular product.

Metal can get into meat products from a number of sources (e.g. grinder blade, broken needle from the needle injector, metal clips, metal pieces from worn equipment). The metal detection system should be sensitive to 'ferrous', 'non-ferrous' and stainless steel metals.

3.12.2 Metal detectors must be located at the point(s) where contaminated products can be effectively isolated and the product is unlikely to be exposed to further metal contamination at subsequent steps.

3.12.3 Metal detectors must be checked against appropriate test pieces daily, and must be calibrated regularly.

Refer to Part 2, Section 10: Calibration of Measuring Devices.

3.12.4 All products that fail metal detection must be isolated from the process line and from acceptable products, and then broken down to determine the reason for failure.

3.12.5 Corrective action must immediately be taken when a batch of product is suspected to have been contaminated with metal.

4 Cooking

Amendment 0

February 2010

4.1 Scope

This section discusses the requirements for the validation and implementation of cooking processes. It applies to the cooking methods commonly used for processed meats in New Zealand. These methods include cooking in water, steam or dry heat.

Processors should also refer to the Heat Treatment section of the [Draft Meat and Seafood Code of Practice Processing](#). Note that once finalised, this section will form part of the [Further Processing Code of Practice](#).

4.2 Outcome of the Cooking Process

4.2.1 The cooking process for a product must be sufficient to render the product microbiologically safe for its intended purpose.

4.2.2 Cooked cured/salted meat products must meet the microbiological limits given in the Food Standards Code, Standard 1.6.1:

	n	c	m	M
Microorganism				
Coagulase positive <i>staphylococci</i> /g	5	1	100	1000
<i>Listeria monocytogenes</i> /25g	5	0	0	-
<i>Salmonella</i> /25 g	5	0	0	-

n = number of samples examined from a lot of food

c = maximum number of samples allowed to have results greater than m but less than M

m = acceptable microbiological level in a sample

M = maximum level which when exceeded in one or more samples would cause the lot to be rejected

These microbiological limits must be identified as regulatory limits in the FSP or RMP.

4.2.3 When cooking is used to control pathogens in ready-to-eat (RTE) products, the cooking process must achieve a 6 decimal reduction of *Listeria monocytogenes* (a 6D process).

This process criterion, or a specific cooking time-temperature that will deliver a 6D process, must be identified as an operator-defined limit in the documented FSP or RMP.

A 6D process for the destruction of *L. monocytogenes* is generally accepted as sufficient to inactivate other vegetative forms of pathogens of concern in a particular meat product. A 6D process delivers a 10⁶ fold reduction of the pathogen (i.e. will reduce the number of bacteria from 1,000,000 to one).

The following time and temperature combinations will deliver a 6D reduction in *L. monocytogenes*. The temperature is the minimum that must be achieved and maintained for at least the corresponding time at the slowest heating point of the product (to be determined based on the product's shape and size).

Temperature (°C)	Time (minutes)
60	44
61	33
62	24
63	18
64	13
65	10
66	7
67	6
68	4
69	3
70-72	2
73-75	1
76 or higher	< 1

(Source: Guidelines for the Safe Manufacture of Smallgoods. Meat and Livestock Australia Ltd, 2003)

4.2.4 The operator may propose an alternative from the 6D process for *L. monocytogenes*. The alternative process must be validated by the operator, and approved by the NZFSA before being implemented.

Reasons for proposing an alternative to the 6D process for *L. monocytogenes* can be:

- a. lower microbiological loading of the raw material and, therefore, the required lethality of the cooking process may be reduced
- b. *L. monocytogenes* is not identified as the target microorganism to be destroyed during cooking; or
- c. additional preservation factors are used to preserve the product and, therefore, the required lethality of the cooking process may be reduced.

NZFSA approval of the alternative process is given through the registration of the RMP or a significant amendment to an RMP, or approval of the FSP.

4.3 Validation

4.3.1 The cooking process must be developed and validated by a suitably skilled person for each product or product group. The process must be revalidated whenever there is a change to the process or product that could impact on its safety.

Validation often involves running trials and collecting data to show that a process is safe and will produce safe product.

4.3.2 The operator must demonstrate that the validated process is capable of consistently achieving the relevant regulatory and/or operator-defined limits.

4.3.3 Smokehouses, steam cookers, water cookers and other types of cookers must be properly installed and set up so they provide uniform temperature distribution throughout the unit.

Temperature distribution studies should be conducted at least annually, or whenever there are changes to the equipment set-up or product arrangement that could impact on heat distribution and transfer. Each cooking unit should be set up so that normal loads of sufficiently spaced and similar sized product can be shown, by core temperature measurements at random sites throughout the unit, to have uniform cooking rates.

If the cooking unit does not have good heat distribution, the cooking process should be validated based on a worst-case scenario (i.e. based on the cooking rate of the product at the coldest part of the cooking unit).

4.3.4 The variation in size and weight of meat pieces must be minimised to ensure uniform cooking in each batch.

4.3.5 The operator must document the validated process parameters and conditions (e.g. cooking times and temperatures, loading capacity, cooker set up) in the FSP or RMP.

Data should be obtained based on a worst-case scenario considering the different factors that could affect the lethality of the heating process (e.g. type and size of the product, type and performance of the cooker, loading configuration of the cooker, loading capacity). Temperature distribution in the cooking equipment, and whether there are hot or cold spots, should be taken into account when validating the process.

In determining the appropriate number of trials to conduct, consideration should be given to equipment performance, product homogeneity and safety margin of the process. As a minimum, for a well controlled process with low variability, at least three confirmatory runs should be conducted. This number should be increased in situations where there is large or unacceptable variation within and between runs, as determined by the suitably skilled person.

4.3.6 Records of all aspects of the validation work must be kept by the operator, including records of the temperature distribution studies.

4.4 Implementation of the Validated Process

4.4.1 Cooking must be operated in accordance with the validated process and procedures.

4.4.2 If the smokehouse or cooker is operated using pre-programmed cooking schedules (e.g. computerised smokehouses), unauthorised access to the programmed parameters must be prevented.

4.4.3 The smokehouse or cooker must be operated within the capacity for which the cooking schedule has been validated for.

The smokehouse or cooker should not be overloaded. Adjustments to cooking cycles may need to be made for partially loaded batches, if this had not been previously considered in the development and validation of the process.

4.4.4 Products must be adequately separated in the smokehouse or cooker to prevent products touching each other.

4.4.5 If a product is cooked in a hot water bath, the product must be completely submerged in the water.

The products should be held at least 10 cm below the water surface with equipment such as a metal screen.

4.4.6 When the cooking step is a critical control point, the process must be carried out and/or supervised by appropriately trained personnel.

The operator must ensure that adequate training is provided and records of the training are kept. The training should cover the operation, control and monitoring of that step.

4.4.7 Calibrated temperature measuring devices must be used for determining internal product temperatures, and cooker temperatures.

Refer to Part 2, Section 10: Calibration of Measuring Devices.

The internal temperature of the cooked meat product must be measured at the coldest spot in the cooker and in the centre of the largest piece of meat.

4.4.8 Records of the cooking process must be kept for each production batch (e.g. cooking times and temperatures, and the product temperature).

4.4.9 The operator must verify that microbiological limits for the product are met.

Routine microbiological testing of all batches of products is not required, but it is recommended that samples of products are occasionally tested as part of the verification programme.

4.4.10 The procedures for preventing post-process contamination of ready-to-eat products given section 9.2 must be complied with.

4.4.11 Cooked products must be immediately cooled after cooking.

4.5 Non-compliance to the Validated Process

4.5.1 The operator must take immediate action when any non-compliance occurs that results in the product or process not meeting the validated process and parameters, including any regulatory or operator-defined limits.

4.5.2 Non-compliant products must be identified and segregated until their safety and disposition has been determined by a suitably skilled person.

Refer to Part 2, Section 17: Handling and Disposition of Non-complying Products, and Recall.

4.5.3 A suitably skilled person must investigate any incidence of non-compliance or process failure, determine the cause of the failure, and determine the appropriate corrective action.

4.5.4 The corrective actions must address the:

- a. restoration of control (e.g. stop processing until the assessment is completed and any necessary changes made to the product or process)
- b. identification and disposition of affected product (including initiating a recall, if necessary); and
- c. prevention of the recurrence of the loss of control.

4.5.5 A record of the assessment and corrective actions taken must be prepared by the suitably skilled person.

The record should be appropriate to the nature of the non-compliance and should include:

- a. date and time of non-compliance or process failure

- b. description of the nature and scope of the non-compliance
- c. description of equipment involved, when appropriate
- d. description of affected product, including code and quantity
- e. corrective action taken, including restoration of control, product disposition and prevention of recurrence
- f. records of any tests undertaken; and
- g. the name and signature of the suitably skilled person.

5 Cooling

Amendment 0

February 2010

5.1 Scope

This section discusses the requirements for the cooling of cooked processed meats. It applies to the different methods commonly used for cooling processed meats, including:

- a. water showers (e.g. inside or outside of oven)
- b. immersion in water or ice water baths; or
- c. refrigerated air flow.

5.2 Outcome of the Cooling Process

5.2.1 Cooked processed meat products must be cooled in a manner and under conditions that minimises the growth of bacterial sporeformers (e.g. *Clostridium perfringens*).

5.2.2 The cooling procedures and parameters must be documented in the FSP or RMP.

Most processors are likely to base their cooling parameters on information from a reputable agency or research institute, or published science journal. The operator may also propose an alternative cooling regime which must be scientifically validated.

Examples of acceptable cooling regimes/criteria for cooked meats are:

1. Australian Standard (AS 4696:2006)

	<u>Temperature</u>	<u>Maximum time (hours)</u>	
		<u>Uncured products</u>	<u>Cured products</u>
Stage 1	52°C to 12°C	6	7.5
Stage 2	12°C to 5°C	Within 24 hours of completion of cooking	

The temperature must be measured at the slowest cooling point of the product. Note that this

cooling regime does not apply to the cooling of fermented meats which have been cooked.

2. USDA FSIS Directive 7111.1

The cooling regime must meet the following criteria:

- a. no growth of toxigenic microorganisms such as *C. botulinum*; and
- b. growth of *C. perfringens* within the product does not exceed 1 log₁₀ accounting for the presence of a lag phase.

3. Alternative to the USDA FSIS criteria (NZFSA)

- a. no growth of toxigenic microorganisms such as *C. botulinum*; and
- b. growth of *C. perfringens* within the product does not exceed 2 log₁₀ where lag phase is not accounted for.

5.3 Validation

The operator must provide evidence that the established cooling parameters can be consistently achieved by all products.

Data should be obtained based on a worst-case scenario considering the different factors that could affect the cooling process (e.g. type and size of the product, type and performance of the cooling facility, loading configuration, loading capacity).

5.4 Implementation of the Validated Process

5.4.1 Cooling must be done in accordance with the validated process and procedures.

5.4.2 The procedures for preventing post-process contamination of cooked or ready-to-eat products given in section 9.2 must be complied with.

5.4.3 Internal product temperatures and/or cooling medium temperatures must be monitored during cooling using calibrated temperature measuring devices in a manner which will not contaminate the product.

5.4.4 Water cooling

5.4.4.1 Water and ice used for cooling (e.g. water sprays or in immersion cooling) must be potable.

The cooling water should be tested regularly and corrective actions taken (e.g. chlorination) to address any identified problem.

5.4.4.2 Cooked products must be transferred into the cooling water tank in a hygienic way. The cooked products must not come into contact with non-product contact surfaces.

5.4.4.3 Products being cooled in water tanks must be completely submerged in the water.

5.4.4.4 Cooling tanks must be emptied and the water replaced as frequent as necessary to maintain it in a hygienic condition.

5.4.5 Air cooling

5.4.5.1 Chillers and freezers must be used within their design capabilities and capacity.

5.4.5.2 Products must be arranged and loaded in the chiller or freezer in a way that will ensure the cooling of all products within the required cooling rate.

5.4.5.3 The addition of warm product into the chiller or freezer must not result in significant warming of cooled product already present in the room, and/or to condensation.

5.4.5.4 Products must be protected from contamination from condensates from refrigeration units and other surfaces.

5.4.5.5 There must be effective separation between raw and cooked products.

Raw products and cooked products should not be held in the same chiller or freezer.

5.5 Non-compliance to the Validated Process

Procedures for addressing any non-compliance to the validated process is given in section 4.5.

6 Drying

Amendment 0

February 2010

6.1 Scope

This section discusses the requirements for the validation and implementation of drying processes. It applies to the processing of ready-to-eat dried meat products such as dry-cured meats (e.g. prosciutto) and jerky-type products (e.g. beef jerky, biltong). The requirements for UCFM products are separately discussed in section 7.

References which would be useful for jerky processors are:

- a. Quick Guide on Processing Jerky and Compliance Guideline for Meat and Poultry Jerky Produced by Small and Very Small Plants
http://www.fsis.usda.gov/PDF/Compliance_Guideline_Jerky.pdf
- b. [Further Processing Code of Practice, Part 3, Section 3: Concentration and Drying.](#)

6.2 Outcome of the Drying Process

6.2.1 The drying process and any additional controls (where used) must render the product microbiologically safe for its intended purpose.

Dried meat products are preserved primarily by the reduction of water activity, however, additional controls are normally applied during their commercial production, which contribute to the lethality of the process to inactivate or inhibit bacterial pathogens of concern. Examples of these additional controls are: the use of salt, nitrite, and/or anti-microbial agents; application of smoke; and heating of the meat before drying.

6.2.2 The product must be dried to a water activity (a_w) that will stabilise the product for food safety purposes. The operator must define this a_w , provide justification for its selection, and identify it as an operator-defined limit in the FSP or RMP.

Standard 1.6.2 of the Food Standards Code (which is mandatory only for Australia) requires dried meat (excluding slow dried cured meat) to be dried to an a_w of ≤ 0.85 . The USDA recommends the same a_w for jerky. At this a_w , the growth of all bacterial pathogens of concern is controlled. The growth of moulds and yeast during storage can be prevented by drying to an $a_w < 0.80$ and vacuum packing, or by drying and maintaining the a_w at ≤ 0.70 (ICMSF, 1988).

Most commercially produced jerky in New Zealand have an a_w of 0.75 to 0.80.

Dry-cured ham ready for sale should have an $a_w \leq 0.90$. At this a_w , dry-cured ham can be regarded as generally safe even when stored without refrigeration (Untermann and Muller, 1992).

6.2.3 The operator must define microbiological limits for any ready-to-eat dried meat product, provide justification for their selection, and identify them as operator-defined limits in the FSP or RMP.

The Food Standards Code does not provide microbiological limits for dried meat products. The operator can establish their own limits based on microbiological limits for similar ready-to-eat meat products; or criteria obtained from a reputable agency or research institute, or published scientific journal.

The following documents can assist operators in defining their limits:

- a. [Guidelines for the microbiological examination of ready-to-eat foods](#)
- b. [Microbiological reference criteria for food](#)

6.3 Validation

6.3.1 The drying process must be developed and validated by a suitably skilled person. It must be revalidated whenever there is a change to the process or product that may impact on its safety.

The person who is responsible for validating drying processes should have good knowledge of the required regulatory and/or operator-defined limits for the product (e.g. a_w , microbiological limits), and the factors that are critical to the drying process and the consistent achievement of the defined limits. The suitably skilled person should also have a good understanding of food microbiology,

process control and the procedures for validation (e.g. preparing a protocol, designing trials, collecting data, product sampling and testing).

6.3.2 The operator must demonstrate that the overall process (i.e. drying and any additional controls) is capable of consistently achieving the defined regulatory and/or operator-defined limits for the product.

The overall process needs to control, reduce, or eliminate the biological hazards identified in its hazard analysis. These hazards will most likely include pathogens such as *Salmonella* spp., *Listeria monocytogenes*, *Staphylococcus aureus* and *E. coli* O157:H7. Drying by itself may not provide enough lethality to inactivate these hazards to an acceptable level, therefore, other additional controls may need to be considered to increase the lethality of the process. For example, in the United States, a heating step prior to drying is mandatory for jerky because studies have shown that traditional air drying methods used were not sufficient to destroy certain pathogens present in raw meat (e.g. *Salmonella*, *E. coli* 0157).

For dried meats which do not undergo a microbiological kill step, such as heating, the safety of the process is mainly dependent on ensuring that:

- a. only meat of good microbiological quality is used for the production of dried meats because there are limitations to the numbers of pathogenic bacteria that can be destroyed during drying; and
- b. the drying conditions (e.g. time, temperature) are such that undesirable microbial growth and toxin formation is prevented, and any existing pathogens are inactivated to acceptable levels.

6.3.3 The operator must document the validated process parameters and conditions (e.g. drying times and temperatures, air velocity, relative humidity, loading capacity, drier set up) in the FSP or RMP.

6.3.4 Drying equipment or facilities must be properly installed and set up so they provide uniform drying throughout the unit.

Validation of the process should be obtained based on a worst-case scenario considering the different factors that could affect the process (e.g. type and size of the product, formulation, type and performance of the drying facility, loading configuration and capacity of the drying facility, air velocity, relative humidity, time and temperature).

6.3.5 Records of all aspects of the validation work must be kept by the operator.

6.4 Specific Procedures for Jerky-type Dried Meats

Jerky and biltong are commonly made by marinating slices of meat and then heating them in a hot air oven under controlled temperature and relative humidity conditions.

6.4.1 Marination and tumbling/massaging of the meat pieces must be done in a manner and under conditions that minimise contamination and the growth of microorganisms.

The meat should be kept at $\leq 7^{\circ}\text{C}$ during marination and tumbling/massaging.

The reduction of water activity by using high concentrations of salt or sugar in the marinade, or the reduction of pH by using acidic marinades (e.g. with vinegar) may slow microbial growth during marination and provide additional preservative effect to the product. For example, traditional biltong is left to cure in salt overnight prior to drying. However, most New Zealand processes use marinades for flavour reasons, rather than for any possible effect on water activity or pH.

6.4.2 Procedures for the preparation, storage and re-use of marinades must be documented in the FSP or RMP.

Some processors recycle or reuse their marinades. This may have a significant effect on the microbiological loading of subsequent batches, and should be considered carefully during hazard analysis.

6.4.3 The drier must be operated within the capacity for which the drying schedule has been validated for.

6.4.4 Products must be evenly spaced in the drier, and pieces of products must not touch each other.

6.5 Specific Procedures for Dry-cured Meats

Microbiological inhibition and inactivation in dry-cured meats are mainly achieved by low moisture content (and low a_w), curing salts, and sodium chloride. Other factors like pH and redox potential (Eh) may also play a role in selecting against undesirable microorganisms.

Traditionally, the processing of dry-cured hams consists of three basic phases (Blanco *et al.*, 1997): (i) the salting phase, in which salt is applied to the surface of the pork leg and the temperature is maintained at low temperature (e.g. below 5°C) (ii) the post-salting phase, in which is salt is distributed uniformly or equalises throughout the ham and temperature continues to be

maintained at a low level for 30 to 45 days, and (iii) the drying and maturation phase, in which a gradual increase of temperature brings about a lowering of the moisture content of the ham allowing for maturation. The duration of the third phase and final phase is highly variable (between 3 and 20 months) and determines the desired type of ham, whose sensory characteristics are influenced by both tissue enzyme – the meat's own enzymes – and microbial activity.

Microbiological stabilisation is achieved with concentrations of sodium chloride below 4.5 to 5%, while the a_w should also be less than 0.96. Only when these conditions are met should the ham be passed from the salting phase, where the temperature is less than 5°C, to the drying phase, where the temperature is gradually increased to 20 to 25°C.

6.5.1 Meats pieces must be salted and cured in accordance with the procedures given in section 3.7.3.

6.5.2 The cured meats must be dried under controlled conditions (e.g. temperature and relative humidity) until the required a_w is achieved.

6.6 Implementation of the Validated Process

6.6.1 The process must be operated in accordance with the validated process and procedures.

6.6.2 If the drier is operated using pre-programmed drying schedules (e.g. computerised driers), unauthorised access to the programmed parameters must be prevented.

6.6.3 The process must be monitored and verified at a frequency necessary to ensure that the established process and product parameters are consistently being met.

6.6.4 Process parameters (e.g. temperature, humidity) and product parameters (e.g. a_w , moisture content) must be measured using calibrated instruments.

Selection of samples for testing is important in drying operations as there may be large variation throughout a batch or run. The operator needs to have good knowledge of their process to ensure that the wettest samples are selected for testing.

Water activity can be determined using a calibrated water activity meter. Processors who do not have access to such equipment can measure moisture content or weight loss instead, but it is necessary to establish their correlation to a_w for the particular product. Establishing the correlation between moisture content or weight loss and a_w for each product produced can be done by having the a_w of product samples that have achieved the intended moisture content or weight loss analysed by a laboratory. Provided that the formulation and processing parameters don't change, their correlation with a_w should remain constant.

Refer to Part 2, Section 10: Calibration of Measuring Devices.

6.6.5 Records of the process must be retained for each production lot.

6.6.6 When the drying step is a critical control point, the process must be carried out and/or supervised by appropriately trained personnel.

The operator must ensure that adequate training is provided and records of the training are kept. The training should cover the operation, control and monitoring of that step.

6.6.7 The operator must verify that a_w and microbiological limits for the product are met.

Routine microbiological testing of all batches of products is not required, but it is recommended that samples of products are occasionally tested as part of the verification programme. Moisture or a_w testing should be conducted on each batch.

6.6.8 Post-process handling, packaging and storage of the dried product must be done in a way that minimises moisture re-absorption and contamination, and maintains the fitness for intended purpose of the product.

It is important to maintain packaging integrity so that the product does not absorb moisture during storage which could allow moulds and yeasts to grow.

6.7 Non-compliance to the Validated Process

Procedures for addressing any non-compliance to the validated process is given in section 4.5.

7 Fermentation

Amendment 0

February 2010

7.1 Scope

This section discusses the requirements for the processing of fermented meat products, such as salami and pepperoni, which are fermented using a starter culture. It does not cover acidulated sausages which use an acidulant (e.g. glucono-delta-lactone) and does not use a starter culture to reduce the product's pH.

Acidulated sausages are expected to be cooked and must comply with the requirements for cooked products given in section 4. An alternative process may be proposed by the operator, which must be validated.

7.2 Uncooked Comminuted Fermented Meats (UCFM)

Processors of UCFM products (e.g. dry and semi-dry fermented sausages such as salami and pepperoni) must meet the requirements of the [Food \(Uncooked Comminuted Fermented Meat\) Standard 2008](#) and comply with the procedures given in [Guidelines for the Production of UCFM Products](#).

7.3 Cooked Comminuted Fermented Meats (CCFM)

7.3.1 CCFM products must meet the microbiological limits for cooked cured/salted meat products specified in the Food Standards Code, Standard 1.6.1 (refer to section 4.2.2).

These limits must be identified as regulatory limits in the FSP or RMP.

7.3.2 A CCFM product that is intended to be shelf stable (i.e. the product can be stored at ambient or room temperature) must have a pH and/or water activity (a_w) which will not allow the growth of any pathogenic or spoilage microorganisms at ambient temperatures. The operator must define these parameters, provide justification for their selection, and identify them as operator-defined limits in the FSP or RMP.

7.3.3 CCFM products which do not meet the established pH and a_w for shelf stability must be refrigerated and stored at $\leq 5^\circ\text{C}$.

It is generally accepted that fermented meat products with a combination of $\text{pH} < 5.2$ **and** $a_w < 0.95$ are shelf stable under ambient conditions (Ross and Shadbolt, 2001). The operator may propose other combinations of pH and a_w , but they must be able to scientifically justify the selected parameters, and validate them, if necessary.

7.3.4 CCFM products must be fermented and dried in a manner, and under conditions, that inhibit the growth of pathogens (e.g. *Staphylococcus aureus*) and the formation of toxins.

Refer to [Guidelines for the Production of UCFM Products for further guidance](#).

7.3.5 The cooking process must be validated and implemented in accordance with the requirements and procedures given in Section 4: Cooking.

8 Smoking

Amendment 0

February 2010

8.1 Scope

This section discusses the requirements for smoking of processed meats. It applies to various types of smoked meats such as ham, bacon, salami and other smoked sausages.

Smoking of processed meats in New Zealand is generally done to produce a sensory effect (aroma, flavour, colour). It is used in combination with other preservation steps, for example, some products may be cooked and smoked, and others may be smoked and dried. Smoke may be produced by burning wood chips or using an acceptable liquid smoke preparation.

Processors should also refer to the [Further Processing Code of Practice, Part 3, Section 5: Smoking](#).

8.2 Procedures

8.2.1 Smoking must be done in a manner and under conditions that minimise contamination of the product and the proliferation of microorganisms.

8.2.2 When smoking contributes to the preservation of a particular product and is necessary for food safety, the smoking process and its effect must be considered in the validation of the overall process.

8.2.3 Smoke flavours are considered as food additives and must comply with the specification listed under Standard 1.3.4 Identity and Purity of the [Food Standards Code](#).

8.2.4 Wood or other plant material used for the generation of smoke must:

- a. not contain toxic substances, either naturally occurring or through contamination with chemicals including paints, wood treatments or other impregnating materials; and
- b. be free from visible microbiological or fungal growth.

There is currently no standard in the Food Standards Code for wood that is used to generate smoke for food processing. Wood product suppliers should follow good manufacturing practice. Operators should obtain supplier guarantees from their suppliers to confirm that untreated wood has been used to produce the wood shavings or sawdust.

Wood shavings and sawdust should be sufficiently dry on delivery and should not be stored in large containers, heaps or silos to prevent spontaneous heating and growth of moulds. Most commercial operations use sawdust which is easier to manage and gives greater smoke volume. The sawdust is often wet down to control burning and smoke density.

Liquid smokes are increasingly being used instead of wood smoke as the process is more repeatable, the composition of the smoke is more constant, it is easier to apply and the carcinogenic compounds (e.g. polycyclic aromatic hydrocarbons) have been minimised. Liquid smokes may be added directly to the product, or may be applied by dipping, spraying, or atomising the liquid smoke and injecting it into the smokehouse, vaporising the liquid on a hot surface, or by using smoke treated casings.

8.2.5 The operator must consider the potential for the formation of chemical hazards such as polycyclic aromatic hydrocarbons (PAH) during the process, and when possible minimise product exposure to them.

There is currently no standard requiring the measurement of PAHs in a smoked product. However, the operator should be aware of the conditions under which higher levels of PAHs are generated and wherever possible, manage those conditions to minimise their formation.

The PAH level in the final product is dependant on a number of factors. For example, the following can result in lower levels of PAH levels:

- a. use of hard wood rather than soft wood (traditionally only hardwoods have been acceptable for smoke generation)
- b. indirect smoking rather than direct smoking
- c. shorter processing times
- d. bigger distance between the product and the heat source (i.e. product located closer to the heat source can have higher PAH levels)
- e. filtering or cooling the smoke prior to use
- f. washing or water cooling the product after smoking; and
- g. keeping equipment clean and maintained.

The operator also needs to be mindful that changes in certain process conditions to reduce PAH may lead to increased levels of other chemical contaminants from the smoke or reduced microbiological safety of the product.

9 Post-processing

Amendment 0

February 2010

9.1 Scope

This section discusses the process steps or activities undertaken after the application of a heat or preservation treatment such as cooking, fermentation, or drying.

9.2 Prevention of Post-process Contamination

9.2.1 The operator must document and implement procedures for preventing post-process contamination of cooked or ready-to-eat (RTE) products.

9.2.2 Separation between raw and RTE product and processes.

9.2.2.1 The design and layout of processing facilities and equipment in the premises must:

- a. facilitate separation between raw and RTE products and processes
- b. facilitate the control of movement of personnel, raw materials and products, and equipment from raw to RTE product areas
- c. facilitate effective cleaning and sanitation between raw and RTE operations; and
- d. prevent cross-contamination between raw and RTE products.

Refer to Part 2, Section 4.2.4.4: Design and Construction of Building and Facilities for further details on design and layout.

9.2.2.2 Raw and cooked or RTE products and processes must be physically separated from each other; or they must be separated by time or distance; as appropriate to the type and size of the operation, and based on an assessment of the potential for product contamination and risk to human health posed by the product.

When processing of raw and RTE products is separated by time, RTE products should be

processed first at the start of the day, when there is no raw product around and when equipment is clean, before processing raw products. Slicing and packing of raw and RTE products could also be done on different days.

When raw and RTE products and processes are separated by distance or location within a room or area, the distance between them should be such that any contact or contamination between products, equipment, processes or personnel is avoided.

9.2.3 Personnel hygiene and movement control

9.2.3.1 Personnel must comply with the hygienic practices and procedures given in Part 2, Section 11.

9.2.3.2 Procedures must be established for controlling the movement of personnel between raw and RTE product areas.

Whenever possible, employees should not work in both raw and RTE areas. Where unavoidable, employees must complete an appropriate hygiene routine every time they move from raw to RTE areas (see section 9.2.3.3).

Different coloured smocks or hats can be used so that workers in the raw and RTE areas can readily be distinguished.

9.2.3.3 Personnel must undergo a hygiene routine before handling RTE products, and every time there is a change from raw to RTE operations. They must:

- a. thoroughly wash their hands
- b. change their protective clothing
- c. clean and sanitise their footwear
- d. discard and replace disposable gloves (or wash and sanitise multi-use gloves); and
- e. ensure that they are free from any contamination originating from raw products/processes and other sources.

9.2.3.4 Outer protective clothing (e.g. smocks, aprons, or disposable protective coverings) used in RTE processing areas must be removed before leaving the area.

9.2.4 Equipment

9.2.4.1 Dedicated equipment (e.g. slicers, conveyors, packing machines, containers, trolleys), maintenance tools and utensils must be used for the RTE and raw product areas; or they must be thoroughly cleaned and sanitised before being used in RTE areas or for RTE products.

Colour-coding may be used to identify portable equipment and utensils (e.g. containers, knives, cutting boards and slicers) for exclusive raw or RTE use.

Different slicers should be used for slicing raw and cooked meat since they can be a major source of recontamination of RTE products.

Pallets are difficult to clean and can serve as a source of cross-contamination. Pallets that are used for raw materials should not be used in RTE areas.

9.2.4.2 Procedures must be established for controlling the movement of equipment between raw and RTE product areas.

9.2.4.3 Wheels of transport equipment (e.g. carts, forklifts, mobile racks) must be cleaned and sanitised before entry to RTE product areas.

9.2.5 Cleaning and sanitation

Cleaning of post- processing areas and equipment must be in accordance with the procedures given in Part 2, section 7.2.6.

9.2.6 Dropped meat procedures

Procedures must be established and implemented for the handling and disposition of products that come into contact with the floor (i.e. dropped meat) and other non-product-contact surfaces.

The procedures should clearly indicate the actions that should be taken (e.g. trim, wash, reprocess or dump) for the different types of products, and how these actions should be done in a hygienic manner.

9.3 Slicing and Dicing

9.3.1 Slicing / dicing and packing must be done in a manner and under conditions that minimises contamination of products and microbiological growth.

Products should be cooled to $\leq 5^{\circ}\text{C}$ before slicing / dicing and / or packing.

9.3.2 The removal of casings, cook-in-bags and other product packaging prior to slicing or repackaging must be done in a way that minimises the contamination of the product.

Some companies dip packaged RTE products in a sanitising solution prior to removing the packaging to prevent contamination of product contact surfaces and products.

9.3.3 Edible trimmings (e.g. sausage and ham ends) must be collected in clean containers. If they are not sliced/diced and then packed or reworked immediately, they must be protected from contamination and placed in a chiller so that their temperature is maintained at $\leq 5^{\circ}\text{C}$.

9.3.4 There must not be any unnecessary delay between slicing and packing.

Products should be packed immediately after slicing.

9.4 Packing and Labelling

9.4.1 The specifications, handling and storage of packaging materials must meet the requirements given in Part 2, Section 13: Specifications, Handling and Storage of Inputs.

9.4.2 Only new packaging must be used for RTE products.

9.4.3 Adequate separation, to prevent product contamination, must be maintained between packaging materials brought into the room for use and exposed product (e.g. use separate tables).

Only enough packaging materials for one shift should be moved into the packing room. Packaging materials must not be stored in the packing room past the end of the shift.

9.4.4 Packaging materials must be dispensed in a manner that protects the materials and the product from contamination.

9.4.5 Packaging machines must be set up correctly so that they produce effective seals.

9.4.6 Packaging seal or closure integrity must be checked regularly to ensure the safety of the product. This may include visual or physical testing (e.g. complete seal, no cracking or wrinkling, maintenance of vacuum).

9.4.7 Products must be labelled in accordance with the requirements given in Part 2, section 15.

9.4.8 Products must be transferred promptly to the chiller or freezer after packing.

9.5 Storage

9.5.1 Chilled products must be maintained at $\leq 5^{\circ}\text{C}$.

9.5.2 The chiller temperature must be monitored continuously (with an automatic temperature reading device), or it must be read manually and recorded at regular intervals.

9.5.3 Chillers must not be loaded beyond their capacity.

9.5.4 Procedures must be in place for identifying and holding finished product awaiting test results for release.

Records should include the total amount of product in the lot or batch and its location.

9.5.5 A first-in-first-out or plant specific rotation inventory control system must be maintained for finished products.

9.5.6 Doors on chillers and freezers must not be left open for extended periods.

Doors should be closed immediately after use.

9.5.7 Products with damaged packaging must be handled in a manner that will minimise:

- a. the exposure or spillage of the product (e.g. products can be wrapped and sealed)
- b. contamination or deterioration of the product; and
- c. contamination of other products and the storage area.

9.6 Repacking

9.6.1 Finished products that do not meet packaging specifications (e.g. coding, labels) may be repacked without receiving any additional treatment provided that the products:

- a. have not been dispatched
- b. are not past their shelf life; and
- c. are of acceptable quality and have been handled properly.

9.6.2 Repacking of product due to damaged packaging must be done in a manner that minimises contamination. Any product that has been detrimentally affected as a result of the packaging damage must be considered as non-complying product.

Refer to Part 2, Section 17: Handling and Disposition of Non-complying Products, and Recall.
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9.6.3 The label of repacked products must indicate the original production code and any shelf-life given must be based on the original date of production of the product.

10 References

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