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| mintrac logo | AMPC logo |

**AMPQUA302**

**Maintain food safety and quality programs**

**Training support materials**

**Australian Meat Processing Training Package**

**Certificate III in Meat Safety**

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| --- | --- | --- |
| **Elements and performance criteria** | | |
| Element | Performance Criteria | Covered on pages |

|  |  |  |
| --- | --- | --- |
| 1. Identify food safety and quality systems in workplace | 1.1 Identify the quality and food safety programs in place in own work area  1.2 Identify the purpose and elements of the quality and food safety systems  1.3 Identify regulatory requirements for food safety and quality relevant to work area |  |
| 2. Identify hazards and control points | 2.1 Identify hazards to food safety and quality for own work area  2.2 Identify critical control points (CCPs) to control hazards for own work area according to workplace requirements  2.3 Identify Hazard Analysis and Critical Control Points (HACCP) plan for own work area |  |
| 3. Follow HACCP requirements | 3.1 Identify workplace requirements of the HACCP system for work area  3.2 Follow procedures to monitor critical limits at CCPs  3.3 Identify any deviation from procedures or critical limits  3.4 Take corrective actions according to workplace requirements and within level of responsibility  3.5 Record food safety and quality information where required by food safety plan |  |
| 4. Monitor food safety and quality in work area | 4.1 Confirm that procedures for controlling food safety hazards and risks are  communicated to others in the work area  4.2 Confirm process of monitoring CCPs to control hazards and risks is communicated to others in the work area  4.3 Identify opportunities for improving food safety and quality, and raise with relevant personnel |  |

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| --- | --- |
| **Required Knowledge**: | |
| **Topic** | **Covered on pages** |
| * purpose of Hazard Analysis and Critical Control Points (HACCP) and quality programs | Y |
| * principles of a CCP analyses approach to managing food safety, including identifying hazards that are likely to occur, establishing appropriate methods of control, and confirming that controls are met | Y |
| * procedures and responsibilities for food safety and quality relevant to the workplace |  |
| * awareness of common microbiological, physical, chemical and allergenic hazards related to meat handled in the work area, including the types of hazards likely to occur, the conditions under which they occur, possible consequences, and control methods to prevent occurrence | y |
| * typical corrective actions taken in work area |  |
| * other quality programs that adopt a CCP approach, including Threat Assessment Critical Control Points (TACCP) and Vulnerability Assessment Critical Control Points (VACCP) and how these plans apply to the workplace |  |
| * Food Standards Code and state/territory food and meat legislation, relevant to work role | y |
| * sections relevant to food safety included in the relevant Australian Standard |  |
| * traceability requirements relevant to the meat processed in work area |  |
| * personal protective clothing and footwear, clothing maintenance, laundering and storage requirements |  |
| * communication methods and techniques to convey information on meat safety and quality requirements to others in the workplace. |  |

**Training support materials for AMPQUA302 Maintain food safety and quality programs**

**Threats to the food safety of meat**

**Which hazards can affect the food safety of meat?**

Applying knowledge of meat safety will ensure that you, and the people with whom you work, can confidently process meat in a safe manner, minimising hazards to the consumer. By maintaining the food safety of meat you can also minimise economic loss due to deterioration of quality or contamination, and avoid the risk of breaking the law relating to meat safety. Meat has the potential to become hazardous or dangerous if it is **contaminated**. This contamination may be caused by three main hazards: biological hazards, chemical hazards and physical hazards. Note that many vendor standards also consider allergens as another type of food safety hazard.

To effectively implement meat safety programs you will require a thorough knowledge and understanding of the importance, advantages and reasons for safe meat processing and handling. As well, you should also understand the consequences and disadvantages if meat safety practices are not followed.

The safety of the consumer is in **your** hands. Not only that, a large part of the economic viability of the meat establishment in which you may be working directly depends on the food safety of meat.

There are many reasons why good meat safety and sanitation is desirable. However, most fall into one of the following categories:

* public health
* financial considerations
* legal requirements.

***Public health***

Correct hygienic meat handling practices in a safe and sanitary environment will minimise the threat to public health by reducing food poisoning and the spread of diseases. This ensures the meat will be of the best possible quality when eaten.

***Financial considerations***

Profits can increase as the establishment’s reputation is maintained and patronage improves. Less wastage results because meat will last longer and will not have to be thrown out. Productivity improves if work is carried out in a more pleasant, efficient workplace where WHS issues are minimised.

***Legal requirements***

Certain standards of hygiene, sanitation and construction are required by legislation. These legal requirements are controlled by state government meat and food inspectors or local council health surveyors or environmental health officers.

Meat processed for export at export registered meat processing establishments is controlled by the Department of Agriculture, Forestry and Fisheries (DAFF).

The basis for food safety for all meat processing in Australia is the AS4696:2023 *Australian Standard for the hygienic production and transportation of meat and meat products for human consumption*. It is called up in the legislation of DAFF and all State and Territory authorities as the basis for food safety in their respective legislations. The Australian Standard mandates the development of a HACCP based Approved Arrangement (AA).

Meat processed for export must comply with the Export Control Act 1982, the Export Control (Prescribed Goods General) Orders 2005 and more specifically the Export Control Meat and Meat Products Orders 2005, which calls up the Australian Standard.

The EC(M&MP)O: 2005 requires that in addition to HACCP based process control, the AA includes management policies and procedures that support the development and maintenance of the AA, and also includes product integrity requirements such as product description, special market requirements (e.g. USA, Halal, EU, Saudi etc.), traceability and recall, security (product and official marks, export documentation and certification.

The ECMMPO also mandates the requirement for meat processed for export to have met the Refrigeration Index, which is a measure of the efficiency of refrigeration systems to reduce meat in temperature to 7°C or less.

In addition to the above, many value added meat products must also meet the requirements within the Food Standards Code for areas such as labelling and allergen identification.

**What is the definition of wholesome in the Australian Standard?**

The *Australian Standard* defines wholesome as:

“*When used in relation to meat and meat products means that the meat and meat products may be passed for human consumption on the basis that they:*

*(a) are not likely to cause food borne disease or intoxication when properly stored, handled and prepared for their intended use; and*

*(b) do not contain residues in excess of established limits; and*

*(c) are free of obvious contamination; and*

*(d) are free of defects that are generally recognised as objectionable to consumers; and*

*(e) have been produced and transported under adequate hygiene and temperature controls; and*

*(f) do not contain additives other than those permitted under the Food Standards Code; and*

*(g) have not been irradiated contrary to the Food Standards Code; and*

*(h) have not been treated with a substance contrary to a law of the Commonwealth or a law of the State or Territory in which the treatment takes place”.*

The main problem likely to cause meat to become unwholesome is microbial growth.

**Micro-biological threats to meat safety**

**What are the main micro-biological threats to meat safety?**

There are many types of micro-organisms that can grow on meat and meat products. These types of micro-organisms if eaten can cause food spoilage and also food poisoning.

Food spoilage is when these micro-organisms are allowed to grow rapidly on the meat and send the meat ‘off’. The meat will have an unpleasant odour, be ‘slimy’ to touch or, in severe cases, have a greenish appearance. This will result in the meat being unwholesome.

The main types of micro-organism that may have an effect on food safety are:

* viruses
* algae and protozoa
* mould and yeast
* bacteria.

***Viruses***

There are a number of viruses that can cause illness from food. These include Rota-virus (flu), Norovirus and Hepatitis A virus. For example, if a food handler has either of these conditions they can be passed on to the consumer.

Note these viruses do not affect animals but are transmitted from infected people by the food. They are transmitted through insanitary conditions, contaminated meat or infected meat handlers.

It is essential therefore to prevent anyone carrying a contagious virus (or any other infectious micro-organism) from passing it on to other people or meat. Spread of viral diseases can also be controlled by:

* maintaining high standards of personal hygiene, e.g. washing your hands after visiting the toilet
* sanitising food premises
* screen testing abattoir workers for Hepatitis A.

***Algae and protozoa***

Algae are microscopic plant life that live in water. They contain pigments (chlorophyll) which make them highly coloured, e.g. green, red, blue etc. Some algae can be toxic. The blue-green algal blooms which can contaminate waterways can cause considerable problems. Certain other micro-organisms such as protozoa can also contaminate water supplies and make them unsafe.

Protozoa are larger and more complex than bacteria and of greater food safety significance than moulds or yeasts

In order to avoid water-borne contaminants, it is important to ensure that only clean, uncontaminated water is used in the abattoirs.

An important protozoan organism, especially overseas, that can cause disease is *Amoeba histolytica*, which causes amoebic dysentery.

Protozoa that have been linked to outbreaks of diarrhoeal disease in Australia include Giardia caused by *Giardia Lamblia* and Cryptosporidiosis caused by *Cryptosporum parvum.*

***Moulds and yeast***

Mould occurs widely and commonly grows on food, resulting in spoilage.

Moulds have been known to contaminate carcases, particularly the abdominal cavity of wild pigs that have been stored for a protracted time in field chillers.

You have probably seen a whitish powdery covering on the surface of some salami; this is mould. In fact, during the maturation step in the manufacture of salami, a very thick coating of mould several centimetres long, can grow on the surface. This is encouraged for flavour reasons and is usually washed off before sale.

Moulds can grow on foods with relatively low moisture, acid pH and of a chemically complex nature, e.g. dry fruits, nuts, grain, jam, cheese, yoghurt, fruit juice, mayonnaise and packaging materials.

Generally, moulds are relatively non-pathogenic. No doubt you have accidentally eaten some mouldy bread, cheese, fruit or vegetable without harmful effects because most species are harmless. In fact, as already mentioned, many moulds are actually added to foods intentionally.

Mould may sometimes been seen in cartoned meat that has been frozen for a long period of time at temperature higher than - 18°C.

**It may look unsightly but it is not pathogenic.**

**Neither moulds nor yeasts are a food safety issue for the meat industry**

**How do bacteria affect meat safety?**

Bacteria are responsible for great economic loss by causing spoilage of foods and because of the effects they have on public health. Additional costs are incurred by the need for preservation technologies and cold chains. There is no measure available for spoilage in the meat industry but it is has been stated anecdotally that 4% of retail meat undergoes “shrinkage” – a retailing term to describe the amount of product which cannot be sold. Figures for losses due to food poisoning were estimated by FSANZ in 1999 to be $2.6 billion annually. Put together, losses due to spoilage and illness have a huge negative impact on the industry.

Clearly, control of bacterial contamination in product underpins every aspect of the industry, from livestock handling through slaughter and dressing, chilling, boning, packaging, transport and retailing. Some key terms used when discussing bacteria are contained in the box (below).

Although many of the bacteria may not be harmful to the consumer, there is the possibility that some may cause food poisoning or even death. Bacteria that cause sickness are called pathogenic bacteria. Bacteria are the main concern in the meat industry. There are many types, but the main bacteria that are of concern to the meat industry are:

* *Salmonella*
* *Staphylococcus aureus*
* *Campylobacter*
* *Bacillus cereus*
* *Listeria*
* *Escherichia Coli (E.coli)*
* *Clostridium perfringens*
* *Clostridium botulinum*

Some key characteristics of these pathogenic microorganisms are summarised below:

|  |  |  |  |
| --- | --- | --- | --- |
| **Micro-organism** | | **Sources in nature** | **Common food sources and growth** |
| *Salmonella sp.* | | Gastro - intestinal tract.  Water | Eggs, poultry, meat, and milk.  Grows at 8oC to 47oC. The optimum is 37oC.  Minimum a*w* for growth ≅ 0.93.  PH range for growth 4.0 – 9.0. Optimum pH 7.  Facultative anaerobe. |
| *Staphylococcus aureus* | | Skin, nose and throat of humans | Poultry products and cold, cooked meats are most common vehicles. Salted meats such as hams and corned meats are particularly vulnerable due to *Staph. aureus* salt tolerance.  Grows at 7oC to 48oC. The optimum is 35oC to 37oC.  Minimum a*w* for growth is 0.83  Minimum a*w* for toxin production is 0.86.  pH range for growth 4.0 - 10. pH range for toxin production 5.15 – 9.0. Optimum pH 6.0-7.0  Capable of growth in 20% salt.  Facultative anaerobe. |
| *Campylobacter jejuni* | | Gastro-intestinal tract of animals | Meat (esp. pork) and poultry. May be found in milk insufficiently pasteurised.  Grows at 28oC to 45oC. Optimum is 42oC to 45oC. Survival recorded at 4 oC.  Minimum a*w* for growth is 0.99.  PH range for growth 4.9 – 8.0.  Microaerobe. |
| *Bacillus cereus* | Soils | | Raw plant foods, cereal products and rice.  Grows at 8oC to 55oC. The optimum is 28oC to 35oC.  Minimum a*w* for growth is 0.912.  pH range for growth 4.35 – 9.3.  Facultative anaerobe. |
| *Listeria monocytogenes* | Soils, water, sewage | | Vegetables, fruit, dairy products (esp. soft cheeses), raw meats and cooked meat products (esp. pate).  Grows at 0oC to 42oC. Optimum 30oC to 35oC.  Minimum a*w* for growth is 0.92 – 0.95.  pH range for growth 4.5 – 9.6.  Facultative anaerobe. |
| *Escherichia coli (EHEC)* | Gastro-intestinal tract of food animals and poultry | | Raw meat, vegetables and dairy products.  Grows at 7oC to 50oC . Optimum 37oC.  Minimum a*w* for growth is 0.95.  Minimum pH for growth 4.4. Optimum 7.0  Facultative anaerobe. |
| *Clostridium botulinum* | Soil and freshwater and marine sediment | | Meat, canned foods shellfish and vegetables.  Type E and non-proteolytic strains.  Grows at 3oC to 45oC.  Minimum a*w* for growth is 0.975.  pH range for growth 4.7 – 9.0.  Obligate anaerobe.  Type A and proteolytic B strains  Grows at 10oC to 48oC.  Minimum a*w* for growth is 0.975.  pH range for growth 4.6 – 9.0.  Obligate anaerobe. |
| *Clostridium perfringens* | Gastro-intestinal tract of food animals | | Meat dishes such as stews and roast joints.  Grows at 12oC to 50oC. Optimum is 43oC to 47oC.  Minimum a*w* for growth is 0.95 – 0.97.  pH range for growth 5.0 – 8.3.  Anaerobe. |

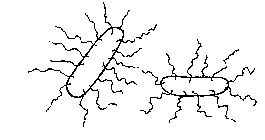
Reference: M.R. Moss and M.O. Adams, *Food Microbiology*.

***Salmonella***

*Salmonella* comes from the digestive tract of animals and humans. There are many types of *Salmonella*, but not all can infect humans. It is, however, one of the best known and common food poisoning micro-organisms.

*Salmonella* can contaminate the meat as a result of the poor personal hygiene of workers and, more particularly during the dressing procedure, from contact with faeces and ingesta.

All animals carry the *Salmonella* bacteria, with pigs being the most likely carriers.

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**Simplified illustration of some Salmonella**

*Salmonella* are rod-shaped non-spore forming organism, so are killed by thorough cooking.

**Illness/symptoms**

*Salmonella* is a food-infection type bacteria and causes inflammation of the intestine resulting in nausea, vomiting, abdominal pain and sudden and frequent diarrhoea, resulting in greenish, foul-smelling stools. **Note:** a person reporting with this condition must not be allowed to work – this should be explained during the induction process.

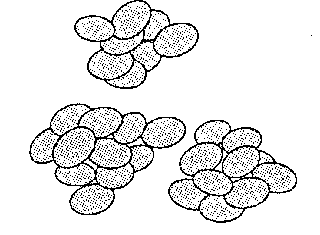
Salmonellosis can be severe. Very young or old people and people who are already ill may die. About 1 in 100 reported cases is fatal.

***Staphylococcus aureus***

*Staphylococcus aureus* is an organism that is found almost everywhere. It lives on the skin of animals and humans and is found in high numbers in the mouth, ears and nose. These bacteria also produce a toxin that if eaten, can cause food poisoning.

Contamination of meat products usually occurs through the poor personal hygiene of workers when touching meat with their hands and arms, coughing or sneezing on product, or through the lack of regular hand washing.

Even if the bacteria is killed, the poison may still be present. It is often called ‘Golden Staph’ because of the golden coloured colonies when grown on culture media. S*taphylococcus* are Cocci in grape-like clusters, non-spore-forming organisms (killed easily by heat) but the toxin would remain as it is heat stable.



**Simplified illustration of Staphylococcus**

**Illness/symptoms**

*Staphylococcus* food poisoning is generally non-fatal. Depending on the level of contamination, illness may develop very soon after eating and may last up to a couple of days. Common symptoms are nausea, vomiting, abdominal cramps and diarrhoea.

***Campylobacter***

Poultry is the most common sources of *Campylobacter* bacteria. Different species of the *Campylobacter* bacteria can cause disease in cattle, pigs and sheep. It is also one of the most common causes of food poisoning in humans.

The bacteria may be found in the gut of animals and humans. It is also found in water supplies. Meat can be contaminated through contact with the contents from the digestive tract, contaminated water, flies or rodents.

***Listeria***

*Listeria* organisms are an environmental contaminant and are a common contaminant of fresh meat. Fresh meat can be contaminated from hide, skin, pelt, faeces or through poor personal hygiene practices. Poor hygiene and sanitation programs are the main cause of contamination. However, eating fresh meat contaminated with Listeria does not usually cause food poisoning. *Listeria* usually causes diseases when it is transferred from fresh meat to ‘ready to eat’ cooked meats.

In abattoirs and boning rooms *Listeria* can be a problem in vacuum-packed meat and in chillers. This is because of its ability to grow at low temperatures.

***Escherichia coli (E.coli)***

Meat is usually contaminated with the *E.coli* bacteria during the slaughtering process as a result of contact with contents of the digestive system. *E.coli* can also be transferred from humans to the product if hands are not washed after visiting the toilet. There are many types of *E.coli* that live in the gut of animals and humans and are generally not considered pathogenic.

However some of these bacteria can cause disease in humans, the most important being referred to as enterohaemorrhagic E. coli. The two most significant pathogenic E. coli of this strain are:

* *E.coli 0157:H7*
* *E.coli O111.*

These can cause severe illness and even death of consumers if they are susceptible to the toxin that the bacteria produces. In this case, it is the toxin that affects the consumer and not the actual bacterium itself. The people likely to be most affected are the very young, the very old and the immuno-compromised, like people who have a disease or condition that affects the immune system and cannot fight off the disease, i.e. at risk groups. The aim of food safety is to make food safe for these groups – then it will be safe for all consumers.

*E.coli* is commonly used as an ‘indicator organism’ in water, because if it is found, it is an indication that the water may also be polluted with sewerage or that the meat is highly contaminated with gut contents.

Australian regulations pertaining to the microbiological standards limit the amount of *E.coli* that is permitted on meat.

**Note**: *Enterohaemorrhagic E. coli* must not be present (commonly referred to as a ‘positive E,coli.’.

***Clostridium botulinum***

This toxin-producing bacteria, although not a common cause of food poisoning, does cause a very serious form of food poisoning known as *botulism*. Botulism may be found in canned or further processed meats and meat products.

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**Simplified illustration of Clostridium botulinum**

*Clostridium botulinum* are rod-shaped bacilli, spore-forming organisms that can withstand boiling (100°C) and require pressure-cooking to kill. Canned foods are pressure cooked to kill *Cl botulinum* spores A 12-D process is required which is roughly equivalent to 121oC for three minutes at the thermal centre.

**Illness/symptoms**

*Botulism* is very serious. The toxin produced is considered to be one of the most deadly around – ranked right up there with funnel web spiders and snakes. The toxin works on the central nervous system. Initially victims have digestive disturbances followed by blurred vision, constipation, fatigue, headaches then gradual paralysis and eventually (in many cases) respiratory and heart failure.

**Control measures**

Control measures for this bacterium are:

* reject swollen or gassy cans. Although *C. botulinum* does not produce gas; gas is an indicator that something is wrong with the can
* reject damaged, dented, rusty cans, as the damage may allow this bacteria to enter and grow
* reject gassy smallgoods – for example pates, salami, meats, etc.

***Clostridium perfringens***

Although related to botulism bacteria, *Clostridium perfringens* is not nearly as dangerous and has relatively very mild symptoms. However, it is far more common and is widely spread in the environment.

Its characteristics are similar to *C. botulinum*. Because of their spore-forming and anaerobic characteristics they commonly cause problems with large volumes/pieces of stews, meats, sauces, etc. that are prepared for re-heating at a later stage. If refrigeration and/or re-heating facilities are inadequate, this bacteria will thrive. Growth is reduced/prevented by ’decanting’ into smaller containers for refrigeration. The thermal centre is smaller and therefore cools more quickly.

**What conditions do bacteria need to survive and cause disease?**

Bacteria because of their small size, are carried inconspicuously in many ways – via wind, dust, insects, humans etc.

This is why a high level of hygiene and sanitation is crucial to control the spread of these micro-organisms.

It should also be noted that, just because some bacteria are motile, does not mean they can travel great distances. Their primary means of movement is still by other sources such as wind, dust, insects and humans.

Not all bacteria are able to produce spores, but those that do are able to survive for considerable time (sometimes years) in very harsh, adverse conditions. This spore formation could happen when their food source is running out, or the conditions are becoming too tough due to excessive heat, cold, drying out or addition of chemicals. This is extremely important information for the food handler. It disproves the idea that by cooking ‘suspect’ food you make it safe. The spores can survive normal cooking.

By understanding which factors or conditions are required by the micro-organisms to grow, you will then be better equipped to reduce their growth rate.

Bacteria will multiply rapidly if the conditions suit. Not all bacteria like the same type of environment. Different types of conditions will affect how different bacteria will grow. This includes:

* temperature
* moisture
* food
* pH
* oxygen
* time.

***Temperature***

For each group of bacteria there is an ideal or optimum temperature for the bacteria to grow rapidly.

Most food spoilage bacteria will multiply in temperatures between 5˚C–45˚C. They grow best between 20˚C–40˚C. They can also grow outside the optimum temperature, but will grow more slowly.

When the temperature is less than 7˚C, bacteria such as *E.coli* and *Salmonella* will stop multiplying but will not die.

When the meat is frozen, most of the bacteria will survive. If the meat is then allowed to thaw and warm up again, the bacteria will continue to multiply when they reach their optimum temperature.

**Low temperature**

Meat should be stored at very low temperatures. The AS4696:2023 *Australian Standard for the hygienic production and transportation of meat and meat products for human consumption* requires carcase meat to be stored below 7˚C and cut up meat and offal below 5˚C. This controls the main pathogens *E. coli* and *Salmonella* but to control other organisms particularly spoilage organisms, meat should be stored as close as possible to its freezing point.

Because meat is not pure water, it does not actually start to freeze until the temperature gets below about –1.5˚C. So, to get the best shelf life out of meat and to make it as safe as possible, it is recommended that is it is stored at –1˚C to 1˚C.

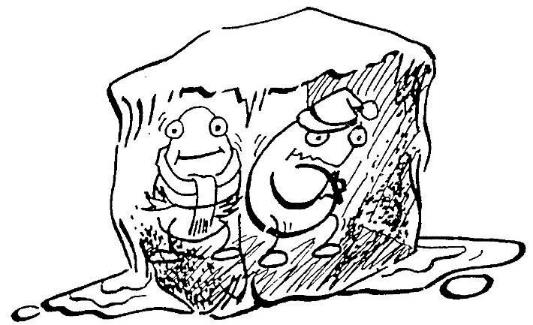
As the temperature gets even lower, eventually all micro-organisms stop growing.

For practical purposes, growth stops when food freezes. The recommended temperature (Good Manufacturing Practice (GMP)) at which you should be operating your freezers is -7˚C or less (-15˚ to -20˚C is the normal setting).

It should be pointed out that it is important to maintain this freezer temperature as closely as possible. This is because wide fluctuation of temperatures would cause the internal structure of the food (cellular structure) to expand and contract. This would then result in damage through rupturing of the food cells, resulting in mushiness, loss of nutrients and fluid on thawing. So, avoid opening and closing freezers more often than necessary.

The fluid that seeps out of the food on thawing, known as **drip[[1]](#footnote-1)**, depends on the freezing conditions: the slower the rate of freezing, or the wider the fluctuations of temperature during freezing, the more drip that results. The more drip that occurs, the poorer the texture and quality of the food and the greater the nutrient and flavour loss in the drip. You have probably noticed bloody liquid when you thaw frozen meat. That is the drip which seeps out of the ruptured cells.

The faster the rate of freezing, the better the quality of the frozen product. Ideally, the temperature should be reduced to the freezer storage temperature of -15˚C to -20˚C within the shortest period possible to ensure the best quality frozen product.



**Some bacteria can survive freezing**

It should be noted that very cold temperatures – even freezing – do not kill all the micro-organisms. Some may die, but most just stop growing and stay in the frozen food. They may survive, dormant, for a long time – even years. When the food is thawed out they ‘come to life’ and are as good as new. In no time they are back to their old tricks of growing and multiplying and causing problems in foods.

The extra moisture (drip) also provides a better medium for growth, hence the need to process cooked thawed meat as soon as possible. ‘Flakers’ process frozen meat without thawing so this problem is avoided.

**High temperatures**

Just as low temperatures affect the growth of micro-organisms, high temperatures can also stop or control the growth of micro-organisms.

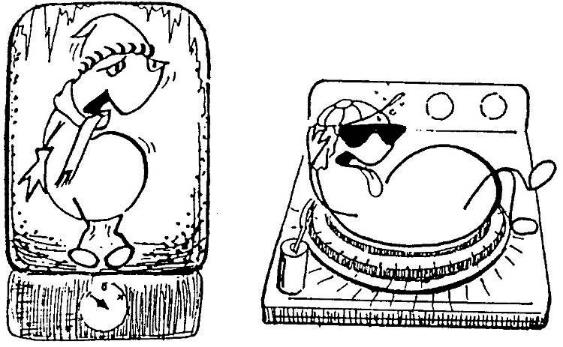
Only a limited number of micro-organisms can grow at higher temperatures. Those that can are termed thermophiles, and they grow best at temperatures of 45˚ to 60˚C.

High temperatures do not only stop the growth of bacteria, most are actually killed when the temperatures get much above 60˚C.

Only heat-resistant, spore-forming bacteria will survive and some are not even killed by boiling.

Only temperatures well above boiling point, such as can be achieved by pressure-cooking (e.g. 120˚C for 10 minutes), will effectively kill spore-forming bacteria.

**Note**: This the autoclaving temperature used for sterilisation of surgical equipment.



**Bacteria can survive in all temperatures**

Canning time/temperatures are a bit lower (e.g. about 120˚C for three minutes). This is commercial sterility, aimed at eliminating botulinum spores but not all spores.

Some spores particularly thermophiles may survive and cause blown cans if the cans are kept in a warm environment for any length of time.

In summary, bacteria can be divided into three groups according to the temperature range at which they grow best.

* Thermophilic – these have an optimum temperature of 45˚–60˚C. They may cause spoilage and food poisoning of foods stored in warmers which are not hot enough. An example of these is Clostridium perfringens.
* Mesophilic – these bacteria have an optimum growth temperature of 20˚–35˚C (i.e. room temperature). This is the temperature at which a majority of food poisoning bacteria will grow. Examples of these are Salmonella and Staphylococcus.
* Psychrophilic and psychotropic – grow at the lower temperature range (i.e. 0˚–20˚C). The food spoilage bacteria Pseudomonas that results in sliminess of meat, chicken and fish is an example of a psychotropic bacteria. However, it is gratifying to note that it is very unlikely that food poisoning would result if the food is stored below 5˚C even though food would spoil slowly.

The only exception being Listeria monocytogenes which can continue growing at temperatures as low as 0˚C.

The chart below summarises the temperature requirements of various organisms.

**Temperature requirements of micro-organisms.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 120°C |  |  | Kills all including spore-formers (pressure cooking/superheated steam) |
|  |  |  |  |  |
|  | 100°C |  |  | Boiling point – kills micro-organisms (except spore-formers) |
|  |  |  |  |  |
|  | 82°C |  | *Safe storage temperature* | Steriliser temperature at abattoirs |
|  |  |  |  |  |
|  | 60°C |  |  | Hot foods must be maintained above this temperature |
|  |  |  |  |  |
|  | 40°C |  |  |  |
| *Growth can occur* | |  | *Danger Zone* | Warm room temperature – most growth – including pathogens |
|  | 20°C |  |  |  |
|  |  |  |  |  |
|  | 7°C |  |  | Maximum meat temperature for the control of Enterobacteriacea e.g. E. coli and Salmonella |
|  |  |  |  |  |
|  | 4°C |  | *Safe storage temperature* | Refrigeration temperature – slow to no growth (*most pathogens controlled except Listeria*) |
|  |  |  |  |  |
|  | 0°C |  |  | Optimum meat storage temperature |
|  |  |  |  |  |
|  | -10°C |  |  | All growth stops (including Listeria) |
|  |  |  |  |  |
|  | -15°C |  |  | Freezer temperature |
|  |  |  |  |  |
|  | -40°C |  |  | Temperature of fast freezing |

***Moisture***

Bacteria need water to survive. Because meat is moist, the bacteria will be able to grow.

Water is essential for survival and growth of all living organisms. Most micro-organisms absorb moisture via their cell wall. It is essential to the micro-organisms, as the nutrients they require must be dissolved (in solution) so that it can then pass through the cell wall (they do not have mouths). The wastes leaving the micro-organisms are also in solution.

For thousands of years, man has left food out in the sun to dry. The removal of water means that the nutrients required by the micro-organisms are no longer in solution. They cannot be absorbed through the cell wall and, without nutrients, they cannot grow and multiply. As long as the food maintains this very low moisture content, it remains stable and can last for a long time – even years.

Effective air circulation around the recently dressed carcase is essential to allow the quick evaporation of moisture from the surface of the carcase. This, together with efficient chilling, helps to inhibit the growth of micro-organisms and in some cases e.g. *E. colisurface* drying will actually reduce microbial populations.

**Binding the water**

There is another totally different way of treating food so that the moisture is no longer available to be used by the micro-organisms, and that is by binding-up the moisture. This is achieved by dissolving very high concentrations of sugar or salt into the food so that the water becomes just about saturated with the sugar or salt. The water then becomes bound up by all this sugar or salt so that it is no longer available to the micro-organisms.

Levels of over 60% sugar are necessary to stabilise most foods. Anything less than this is not effective (in fact lower levels of sugar actually will promote or speed up the growth of micro-organisms which use it for food).

Jam, glazed fruits, honey, lollies, etc. are all examples of foods with low available water content due to high concentrations of sugar.

Levels over 10% are used in some products e.g. salted meat/fish and Vegemite are preserved in this way, using concentrations of salt instead of sugar.

The preservation of smallgoods is assisted by about 2.5-3% of salt in addition to cooking, drying etc.

**Available water or water activity of the food**

It is the available, rather than the total amount of water, in a food that will determine whether micro-organisms would be able to grow. The level of available water is expressed on a scale of 0 to 1, in units known as water activity (Aw).

An Aw of 0.0 means that there is no water available while an Aw of 1.0 is in fact pure water. These are the extremes. Micro-organisms do not grow at the low levels of Aw.

Micro-organisms vary according to the Aw level they require. Generally, bacteria require a high Aw to grow (above 0.9). But *Staphyloccocus aureus* can grow with a Aw as low as 0.83 although toxin formation stops at 0.86.

Yeast can grow at high to medium levels.

Moulds are more versatile and can grow at lower levels of Aw as well as high levels (above 0.8).

Micro-organisms which can tolerate low Aw levels are referred to as osmophilic. Nearly all osmophilic mocro-organisms are yeasts.

Micro-organisms that can tolerate low Aw due to salt are called halophilic. *Staphyloccoci* are moderately halophilic.

The stability of foods is dependent on the Aw. Foods with a high Aw are generally much more prone to microbial spoilage than foods with a lower level of available water (Aw).

Some examples of various foods are in the table below.

|  |  |  |
| --- | --- | --- |
| **Aw Level** | **Foods with this Aw** | **Micro-organisms that will grow or spoil the food** |
| 1.00–0.95 | High risk perishable foods such as meat, milk, fish, fruits, vegetables, etc. | Most micro-organisms (bacteria, yeast and mould). Food poisoning bacteria in particular. |
| 0.95–0.90 | Cheeses, processed meats such as salami, ham, etc. Concentrated fruit drinks and cordials. Salty foods such as pickled herrings. | Moulds, yeasts and some bacteria, including the food spoilage bacteria *Lactobacilli* as well as some food poisoning bacteria such as *Vibrio* and *Salmonella*. |

***Food***

Bacteria like protein as food. Meat is an ideal nutrient as are fish, eggs and dairy products.

***pH***

pH is a measure of how acidic or how alkaline a liquid is. Because there is a high moisture or water content in meat, we can measure the acidity or alkalinity (pH).

The pH is usually measured on a scale of 0 to 14.

For example:

* battery acid is about 1
* meat is 5.4-7
* pure water is 7
* soap is 12
* caustic soda is 14.

Most bacteria like it best when the pH is close to neutral, but some bacteria can survive in acidic conditions as low as 4 or in alkaline condition as high as 11.

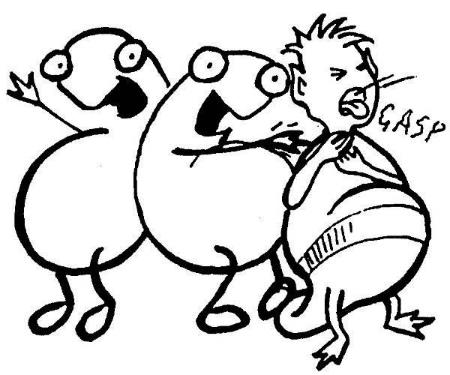
The pH of meat is normally in the range 5.3-5.8, which is ideal for bacteria.

Resting the animal before slaughter allows the build-up of the blood sugars called glycogen, which is later converted to lactic acid in the meat. This lowers the pH so the meat is less prone to spoil.

***Oxygen***

Bacteria can also be grouped according to their need for oxygen:

* aerobic bacteria need oxygen to survive, e.g. *Pseudomonas,*
* anaerobic bacteria cannot grow in the presence of oxygen e.g. *Clostridia*
* facultative anaerobes can grow with or without oxygen e.g. *Salmonella, Staphylococcus aureus*
* Microaerophilic e.g. *Lactobacilli* in vacuum packaged (low oxygen) meat.



**Not all micro-organisms require air!**

By processing foods in different ways, you can use these differing oxygen needs to control the growth of micro-organisms. This will control the rate of food poisoning or food spoilage.

Vacuum packing or ‘Cryovac’ is a good example of this. In this process, the meat is placed in a strong plastic bag, all the air (and oxygen) is sucked out and the bag is sealed.

The small amount of oxygen means that the aerobic micro-organisms, which would rapidly spoil the meat, are inhibited. So instead of only lasting a few days, the meat has a shelf life of many weeks if maintained at low temperatures (below 1˚C).

Likewise modified atmosphere packaging (MAP) is the practice of modifying the composition of the internal atmosphere of a package in order to improve the shelf life.

The modification process often lowers the amount of oxygen (O2), moving it from 20.9% to 0%, In order to slow down the growth of aerobic organisms and the speed of oxidation reactions. The removed oxygen can be replaced with nitrogen (N2), commonly acknowledged as an inert gas, or carbon dioxide (CO2), which can lower the pH or inhibit the growth of bacteria. Carbon monoxide can be used for keeping the red colour of meat.

***Time***

Bacteria also need time to multiply. The longer bacteria remain in the conditions they like the more the bacteria will multiply. Bacteria multiply by splitting one bacterium in half to form two bacteria. Those two bacteria then split into four, and so on and so on. As shown in the following chart, this process can happen every twenty minutes if the bacteria are in conditions that are suitable.

As an example Clostridium perfringens has a generation time of seven minutes under optimal conditions.

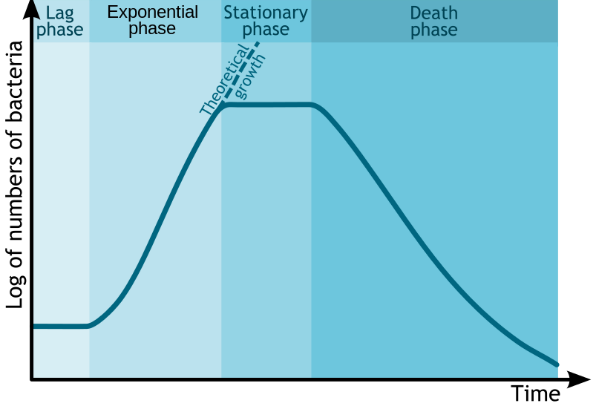
|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Time (mins.)** | **20** | **40** | **60** | **80** | **100** | **120** |
| 1 bacterium | 2 | 4 | 8 | 16 | 32 | 64 |
| 10 bacteria | 20 | 40 | 80 | 160 | 320 | 640 |
| 50 bacteria | 100 | 200 | 400 | 800 | 1,600 | 3,200 |
| 1000 bacteria | 2,000 | 4,000 | 8,000 | 16,000 | 32,000 | 64,000 |

This rate of multiplication means that in ideal conditions one bacterium can multiply to seven million in about seven hours.

There are four phases of bacterial growth.

* the lag phase
* the exponential phase
* the stationary phase
* the death phase.

The diagram below shows these four stages of growth.



During lag phase, [bacteria](http://en.wikipedia.org/wiki/Bacterium) adapt themselves to growth conditions. It is the period where the individual [bacteria](http://en.wikipedia.org/wiki/Bacterium) are maturing and not yet able to divide.

During the exponential phase, the number of new bacteria appearing per unit time is proportional to the present population. This gives rise to the classic [exponential growth](http://en.wikipedia.org/wiki/Exponential_growth) curve, in which the [logarithm](http://en.wikipedia.org/wiki/Logarithm) of the population density rises linearly with time. Exponential growth cannot continue indefinitely, however, because the medium is soon depleted of nutrients.

During stationary phase, the growth rate slows as a result of nutrient depletion and accumulation of toxic products. This phase is reached as the bacteria begin to exhaust the resources that are available to them.

At the death phase, bacteria run out of nutrients and die.

**What are the effects of micro-biological contamination?**

These are a number of effects that micro-biological contamination may have. Some of these are:

* reduced shelf life
* food poisoning
* negative effect on the meat industry’s image.

***Reduced shelf life***

The shelf life of meat is how long meat can be kept, before it becomes ‘unwholesome’.

If contamination occurs through unsanitary dressing, poor handling or unsatisfactory chilling and transportation, the bacterial load on the carcase will be much higher.

This may result in the surface becoming slimy to touch, an unpleasant odour and a colour change – green in severe cases.

Carcases and meat which have been processed, chilled, handled and transported correctly will last for considerably longer.

Problems that could result from product with poor shelf life could be:

* rejection by butcher, supermarket, wholesaler or other customers
* meat is condemned
* financial loss for company or customer
* loss of customers
* consumer complaints.

Storage temperature (history) also eventually affects wholesomeness.

Freezing – Hard frozen (all through) begins at -1.5°C and meat is frozen at <-4°C.

There is no significant bacterial growth <-6°C.

There is no mould growth <-8°C.

Institute of Refrigeration recommend that meat frozen <-10°C has a shelf life of 5 months (4-12).

No chemical reactions such as development of rancidity at or below -18°C.

***Food poisoning***

If the carcase or meat contains pathogenic bacteria and this is not killed during the cooking process, the consumer can be affected by food poisoning from the following bacteria or their toxins.

***E.coli***

|  |  |
| --- | --- |
| Incubation period: | i.e. the time it can take from eating the bacteria and/or toxins to when the symptoms appear, 2 hours–10 days, usually 3–4 days |
| Symptoms: | diarrhoea, bloody diarrhoea, stomach cramps, vomiting and fever |
| Effects: | dehydration, anaemia, kidney failure and possible death |
| High risk groups: | young children, elderly, immune compromised |

***Salmonella***

|  |  |
| --- | --- |
| Incubation period: | 12–36 hours |
| Symptoms: | diarrhoea, nausea, vomiting, abdominal pains, chills, headaches and muscular weakness, green foul-smelling stools |
| Effects: | healthy adults recover after a few days, can dehydrate, collapse or even die. They can also become ‘carriers’ of the *Salmonella* bacteria |
| High risk groups: | sick, elderly, infants or immune compromised |

***Staphylococcus aureus***

|  |  |
| --- | --- |
| Incubation period: | 1–6 hours |
| Symptoms: | vomiting, nausea, abdominal cramps and diarrhoea |
| Effects: | recovery after several days |

***Campylobacter***

|  |  |
| --- | --- |
| Incubation period: | 2–11 days |
| Symptoms: | diarrhoea, severe abdominal pains and fever |
| Effects: | can make you very sick and can last for 3–14 days |
| Source | mainly from poultry |

***Listeria***

|  |  |
| --- | --- |
| Incubation period: | 4–21 days |
| Symptoms: | influenza like symptoms and possibly septicaemia and meningitis |
| Effects: | can be fatal |
| High risk groups: | infants, the elderly, immune compromised and pregnant women |

***Negative effects on the meat industry’s image***

Consumers’ image of the meat industry can be badly affected by bad publicity about people becoming ill, or even dying, from food poisoning related to meat.

This can have a huge impact on all employed in the meat industry. Some of the consequences could be:

* poor public confidence in meat and meat products
* reduced consumption
* export registered establishments may lose registration
* export markets may be lost
* reduced sales
* loss of jobs.

It is up to everyone in the meat industry to do everything possible to avoid contaminating the product.

**Preventing micro-biological contamination**

**Where do these bacteria come from?**

Three main sources:

* raw materials – animals (sanitary dressing)
* plant equipment and the processing environment
* food handling personnel, waste handlers, visitors, maintenance staff.

It is important that all necessary steps are taken to avoid any contamination of meat from bacteria.

The definition of contamination in the AS4696:2023 *Australian Standard for the hygienic production and transportation of meat and meat products for human consumption* is:

*‘The presence of objectionable matter (including residues, microorganisms or matter that has been subjected to ionising radiation contrary to the Food Standards Code) or any substance which may compromise food safety or wholesomeness.’*

Possible sources of contamination that could be a risk to meat safety during sanitary dressing and the processing environment include:

* water splash
* hair/wool
* contaminated blood
* faeces/ingesta
* hide rollback
* contaminated water.

***Water splash***

It is important that any washing of stands, platforms or equipment is done when carcases are not present or close enough to be contaminated. This is because splashing from the stands, platforms or equipment during washing can contaminate the carcase with bacteria, e.g. *Salmonella* or *E.coli*. **Never** clean a chiller with carcases in it.

You must wash your equipment in the area and with the equipment set aside for this purpose. Any other washing should only be with water under normal pressure – high volume and low pressure – to prevent splash contamination.

***Hair/wool***

To avoid contamination from hair or wool it is important that opening cuts are performed in a way that prevents contamination of the carcase. The spear cut is one of the most effective ways to achieve this during the dressing procedure.

The spear cut is carried out by inserting the point of the knife under the skin at the start of the cutting line. Then, by using a continuous pushing action, you direct the cut from the inside of the hide outwards, pushing hair, faeces and other possible contamination away from the carcase.

During all dressing cuts you must only allow the blade of the knife to come in contact with the surface of the carcase.

***Contaminated blood***

During bleeding, you must bleed the animal in a way that lessens the chance of blood splashing onto other carcases. This is so that the carcase is not contaminated by contaminated blood from hide contact. Carcases should not be touching during bleeding. It is particularly important to ensure proper separation between carcases, so that the feet cannot contaminate sticking wounds. Refer to the construction and equipment guidelines for this assistance.

***Faeces/ingesta***

Workplace instructions to eliminate or reduce faecal and ingesta contamination containing *E.coli* or *Salmonella* must be followed. This is very important when:

* ensuring that stock are clean when presented for slaughter
* rodding and sealing of the weasand
* carrying out the bung cut
* removing the hide, pelt or skin
* removing the digestive tract
* preparing head meats.

***Hide rollback***

Sometimes, after cutting or clearing the hide, skin or pelt, it will roll back towards the carcase. You need to clear the hide so that the surface of the outer hide, skin or pelt does not come in contact with any part of the carcase or any other carcase. This is to avoid contamination containing *E.coli* or *Salmonella*. If this is not possible, you may use clean sheets of suitable material such as legging paper, to prevent contact. Another preservation measure is to use a device such as pins or clips, to pin back the hide to prevent rollback or flapping. The work instruction for the Food Safety Program will detail the requirement.

***Contaminated water***

Workplace instructions should be followed when chlorinating water supplies to eliminate bacteria. You must ensure that only potable water is used.

|  |  |
| --- | --- |
| **WI** | **What are the ways in which cross-contamination can occur?** |

Cross-contamination is when contamination is passed from one surface to another.

***Carcase to carcase***

Carcases that have been contaminated and come in contact with others can transfer contamination from one carcase to the next and so on. To stop carcases touching each other, you must have adequate rail space and mechanical stops or a mechanical chain. This is needed from the first dressing cut, until the carcase has been passed fit for human consumption (in particular on retain rail).

***Equipment to carcase***

Equipment that has become contaminated can transfer contamination to the next carcase or meat product you work on.

***Worker to carcase or meat***

Contamination can be transferred from workers’ hands, uniform and arms to the carcase or meat, or from the equipment to the carcase or meat. To avoid this, you must follow hygienic practices such as regular hand washing, washing hands when contaminated; ensuring aprons are clean along with washing and sterilising equipment.

Workplace instructions for hygiene and sanitation procedures must be followed.

**What should you do if contamination occurs?**

If contamination occurs, you must take **immediate** action to correct the situation. The action you need to take will be included in your workplace HACCP program.

Before washing the carcase, all visible contamination must be trimmed using a knife or other suitable equipment, and condemned according to workplace instructions.

You must not remove contamination by either scraping, wiping or washing. If you do this, you will only be spreading the contamination over the carcase or meat.

**How can we reduce this micro-biological contamination?**

There are many ways in which you can prevent micro-biological threats or hazards to meat and meat products. Some of these could include:

* implementing HACCP (Hazard Analysis Critical Control Point)
* following work instructions for processing and further processing
* avoiding contamination
* correctly removing contamination
* following hygiene and sanitation procedures
* using preservation techniques to control the growth of micro-biological organisms
* chlorinating water.

All meat processing establishments are now required by the AS4696:2023 *Australian Standard for the hygienic production and transportation of meat and meat products for human consumption* to have process control systems in place using HACCP. Using the HACCP method, all possible contamination hazards (micro-biological, physical and chemical) must be identified at each step of the process.

These hazards must the analysed, Critical Control Points (CCPs) determined, control measures put in place and corrective action undertaken when these hazards occur.

You must ensure your workplace HACCP procedures and instructions are followed and that meat safety hazards have been identified and listed according to workplace requirements.

|  |  |
| --- | --- |
| **SOP** | **What are the hygiene and sanitation requirements in meat processing?** |

All food handling personnel, waste handlers, visitors, maintenance staff and even office staff who may on occasion come in contact with meat must adhere to company policy with respect to personal hygiene and dress in the processing environment.

Hygiene and sanitation requirements are covered in detail in the training materials for *AMPCOR202 Apply hygiene and sanitation practices*. Revising these requirements will assist you in identifying micro-biological and chemical threats to meat safety. This revision could include:

* diseases
* injury
* accidental contamination
* toilets
* clothing
* hand washing
* protective clothing
* equipment.

You will need to know and follow those hygiene and sanitation requirements that are important to your workplace. SOPs and workplace procedures will help you do this.

**What processes are used to control microbiological spoilage of meat?**

Meat is considered spoiled when its appearance or odour do not meet customer expectations. Traditionally, retail chilled meat has been packed in trays with an overwrap which has low water permeability (to retard moisture loss) and high oxygen permeability (to enhance colour retention). Held under refrigeration the product is susceptible to spoilage by psychrotrophic, aerobic bacteria with *Pseudomonas* and related genera growing most quickly.

In order to grow, bacteria need an energy source and the source of choice is glycogen. When sugars are broken down they yield water and carbon dioxide as by-products, which do not contribute to spoilage. However, pseudomonads are biochemically active and also break down meat protein into two sets of compounds which have obnoxious odours: amines produce odours which are associated with rotting flesh and sulphur compounds produce odours like rotten eggs.

When aerobic spoilage of meat occurs, odour becomes apparent when the TVC reaches around 50,000,000/cm2. The second consequence of spoilage is slime formation (this is when bacterial colonies become so dense that they join up to form slime) that occurs around 100,000,000/ cm2.

There is an increasing tendency to pack meat in films that have low oxygen permeability, either as vacuum or in modified atmosphere packs. In both systems the carbon dioxide level is high enough to prevent growth of Gram-negative spoilers, allowing Gram-positive spoilers, such as *Lactobacillus* to become the main microflora.

In vacuum packed meats lactobacilli grow slowly giving a shelf-life around 100 days –1°C. The reason for such a long shelf-life is that lactobacilli tend not to break down protein, focusing on glycogen, which they break down to lactic acid. So souring is the product of bacterial growth in vacuum and modified atmosphere packs.

Because the products of *Lactobacillus* growth are less obvious the TVC of vacuum packed meat can reach 100,000,000/ cm2 without the meat being rejected.

When dark cutting meat is vacuum packed the high pH allows *Shewanella putrefaciens* (a relative of *Pseudomonas*) to grow and, because there is little or no glycogen, protein is used as an energy source. This results in release of amines and sulphur compounds and early spoilage of the product, often at a TVC around 1,000,000/ cm2.

Psychrophilic clostridia can spoil vacuum packed meats by producing cheesy odours and gas, which can cause the pack to explode.

Mesophilic clostridia have been associated with bone taint in the deep muscles of large cattle which have been cooled too slowly; the “20/20” rule where deep tissues are cooled below 20°C in no more than 20 hours has been shown to control bone taint.

There are a number of processes that can be used to prevent or limit spoilage of meat:

* chilling
* freezing
* vacuum packaging
* heat
* salting
* fermentation
* drying (Less than 0.85 Aw)
* chemicals.

The most common preservation processes in a slaughtering and boning premises would be chilling, freezing and vacuum packaging. Temperature control is crucial to prevent micro-biological growth in these processes.

The *Australian Standard* sets out the following temperature requirements for chilling, freezing of meat:

*11.4 During primary chilling carcases, sides and quarters do not come into contact with each other.*

*Note For requirements that carcases and carcase parts do not come into contact with other surfaces.*

*11.5 The loading of hot carcases into chillers containing chilled carcases does not result in the warming of the chilled carcases or their contamination with condensed moisture.*

*11.6 Refrigeration for the chilling and freezing applied to carcases and carcase parts achieves:*

*(a) chilling with continuous temperature reduction within 24 hours after the stunning of the animal from which the carcase or part is derived:*

*(i) for a carcase, side, quarter or bone-in major separated cut: a temperature of no warmer than 7 °C on all its surfaces; and*

*(ii) for any other carcase part: a temperature of no warmer than 5 °C at the site of microbiological concern; or*

*(b) chilling of hot boned carcases and carcase parts in accordance with the requirements for hot boning specified in the approved arrangement and within the following refrigeration index criteria:*

*(i) the refrigeration index average is to be no more than 1.5; and*

*(ii) 80% of refrigeration indices are to be no more than 2.0; and*

*(iii) no refrigeration index above 2.5; or*

*(c) the alternative time and temperature controls for chilling the carcase or carcase parts that are specified in the approved arrangement; and*

*(d) if the carcase or carcase parts are to be frozen, the refrigeration controls for freezing:*

*(i) ensure that the carcases or carcase parts are hard frozen without delay after compliance with requirements for chilling in paragraphs 11.6(a), 11.6(b) and 11.6(c); and*

*(ii) achieve the controls that are specified in the approved arrangement.*

*Note For the meaning of site of microbiological concern and refrigeration index criteria see clause 1.3.*

*11.7 If paragraph 11.6(c) applies the meat business demonstrates in the approved arrangement that achieving the alternative time and temperature controls for the chilling and the way in which this will be done will not adversely affect the microbiological safety of the carcases and carcase parts.*

*11.8 Other than when a process is being applied to them carcases and carcase parts are maintained at:*

*(a) the temperature specified for the carcase or carcase part in paragraph 11.6(a); or*

*(b) the alternative temperature specified for the carcase and carcase parts in the approved arrangement.*

*11.9 If paragraph 11.8(b) applies the meat business demonstrates in the approved arrangement that maintaining the carcases and carcases parts at the alternative temperature and the way in which this will be done will not adversely affect the microbiological safety of the carcases and carcase parts.*

But export legislation –The Export Control (Meat & Meat Products) Orders, which applies at all export registered plants have additional requirements for chilling and freezing.

The main difference being a requirement for all meat be chilled according to the refrigeration index and not just hot-boned meat.

***Boning rooms***

The *Australian Standard* states that if surface temperature of carcases rises above 7˚C, the room must have an air temperature of no more than 10˚C.(Clause 12.4)

To avoid temperature build up, carcases and piece meats should flow continuously, so that there is regular turnover of product.

Where meat left on the bone is removed mechanically, the edible meat recovered must be reduced to 5˚C as soon as possible.

***Vacuum packaging***

The shelf life of correctly stored vacuum packaged meat is typically thought of as twelve weeks.

Vacuum packaging of meat is performed by first placing meat into a special plastic bag. The air is then sucked out of the bag, removing the majority of oxygen and sealed. This is done using a vacuum-packing machine.

Another method used is when the bag is filled or flushed with carbon dioxide first. This is then removed from the bag, resulting in no oxygen and only small amounts of carbon dioxide remaining.

These methods eliminate the oxygen. Because the main bacteria that are of concern are aerobic, i.e. need oxygen, this will prevent the aerobic bacteria growing. Bacteria that will grow under vacuum packaging are microaerophilic bacteria. These can be controlled by temperature and good packaging techniques.

Modified atmosphere is another method used. This is where carbon dioxide or a combination of carbon dioxide, nitrogen and oxygen is pumped into the bag containing the meat.

Critical requirements for a long shelf life of vacuum packaged chilled meats include:

* low bacterial load on initial product
* minimal handling of product
* good hygiene and sanitation
* proper temperature control of meat
* correct sealing of bags to ensure there are no ‘leakers’
* low storage temperatures 0–2˚C to extend shelf life.

***Freezing***

Although there are no temperatures specified for freezing in the *Australia Standard*, freezers should be able to maintain an air temperature of -18˚C or colder to avoid deterioration of product.

***Storage***

In storage facilities such as chillers and freezers, you must be able to store the produce to avoid contact, contamination, splash and drip. The air must be able to circulate around the product, to make sure the product is brought down to the required temperature in the required time. The spacing of carcases in chillers is very important to make sure the surface dries to prevent micro-biological growth.

|  |  |
| --- | --- |
| **WI** | **Monitoring** |

Temperatures of chillers and freezers must be monitored as part of the HACCP program. Equipment for the accurate monitoring of temperatures must be provided in chillers and freezers when in use.

Monitoring of the storage process in freezers is also required for edible product and is part of the required HACCP program.

***Thawing***

The *Australian Standard* requires thawing to occur under refrigerated conditions of no more than 10˚C and the temperature of the surface of the product must not rise above:

* 7ºC for carcases or parts of carcases and
* 5ºC for smaller pieces such as carcase parts and offal.

***Transportation of meat***

It is very important that, during transport of meat products, the temperature control is carefully monitored. A requirement of the *Australian Standard* is that the surface temperature of carcases and quarters must be 7˚C, and the internal temperature of meat less than quarters at 5˚C, before being removed from a chiller for transportation.

These temperatures must be maintained during transport.

Accurate equipment must be provided for the monitoring and display of temperature. This equipment should be regularly calibrated.

Good hygiene and sanitation procedures must also be followed when handling meat during transport, to prevent micro-biological spoilage.

Insects and rodents must be prevented from entering the carrying compartments as they may also be a source of micro-biological contamination.

***Export requirements***

The basic export requirements for the temperature control of products are the same as the *Australian Standard*.

But importing countries have some further requirements as set out in *Meat Manual Volume 2* and relevant circulars, for example -12°C for EU eligible product

In all cases, workplace instructions and procedures must be followed.

***Preservatives or inhibitors***

Strict food regulations control the type and quantity of preservatives that are permitted additions to specific types of food. They can only be added after exhaustive tests have been carried out regarding their safe use in foods. Finally, government authorities are constantly monitoring the use of preservatives in meat products and other foods, helping to ensure that they are being used appropriately, safely and effectively.

Additives used to control spoilage in foods can be divided into two general groups.

* Natural inhibitors or preservatives including large concentrations of salt, sugar, alcohol, vinegar and spices. Although these types of compounds are popularly referred to as ‘natural’ by most people, they are in fact, ‘chemical’ in nature and, in some cases, not all that good for you if used incorrectly.
* Chemical preservatives are sometimes referred to as artificial. These types of additives can only be added to specific foods in controlled (very small) amounts. The level of use is usually less that 0.1%.

**Nitrites**

Nitrites are used in most processed meats at levels of about 125ppm (controls the growth of most food poisoning micro-organisms including the deadly *Clostridium botulinum*). Salami, ham, bacon, in fact just about all smallgoods, rely on the use of nitrites to inhibit the growth of micro-organisms.

Use is regulated- since it is considered a carcinogen at excessive levels. It is therefore a potential chemical contaminant in excess.

**Sulphur dioxide**

Used in sausages – can initiate asthma in allergic consumers.

**Chemical hazards of meat and meat safety**

**What are the chemical hazards for meat and meat safety?**

In addition to the micro-biological hazards caused by bacteria, moulds, yeast and viruses, there are chemical hazards which will affect the safety of meat, making it potentially unfit for human consumption.

***Poisonous food and poisonous plants***

Some ‘foods’ contain chemicals that are naturally poisonous and are sometimes eaten accidentally or due to lack of knowledge.

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**A sample of poisonous items**

There have been many instances of food poisoning caused by meat because the animal has previously eaten certain plants. For example, animals can suffer from mulga liver (Also known as bore-water liver), which is caused by eating the leaves of mulga scrub. It is mostly seen in sheep. The liver gradually changes colour from brown to grey-black as lipofuscin granules deposit in liver cells. The portal lymph node slowly becomes greyish black. The lungs may also show a very slight colour change.

Soursop is a small plant with high levels of oxalic acid. It occurs in Western Australia and South Australia, with some cases in southern New South Wales. It mostly affects sheep and causes lesions in the kidneys (pulpy kidney). This poisoning can then be passed on to the consumer.

***Allergens in food***

Some people are allergic to certain foods, the ingredients within them or have an intolerance to them. The most common foods that cause allergic reactions or other signs of intolerance include peanuts, treenuts such as almonds or walnuts and dairy products.

It is rare for people to be intolerant or allergic to meat. But additives added to meat during smallgoods manufacture can be a problem to some people. In particular sulphites added to meat as a preservative. It is prohibited in all meat other than sausage meat. Also allergens present within ingredients used for value-added products must be identified and controlled if applicable. For example marinades can include wheat, nuts and soy.

One purpose of food labelling is to alert consumers to potential allergens in the food and used within the workplace

The allergens of concern in Australia and New Zealand are listed within the Food Standards Code. If present within the food, they must be identified to the end consumer. This is usually achieved by a product label or specification.

***Chemicals or additives getting into the meat***

Sometimes foods become poisonous because chemicals or additives find their way into the food. This can occur accidentally or, in some rare cases, by deliberate addition. Some foods can become contaminated and cause injury or illness.

Some cleaning compounds, detergents and sanitising agents are also toxic and should be used only as directed. Do not allow them to come into contact with foods. Secure storage areas should be made available for these and other hazardous chemicals such as insecticides, to minimise the risk of contamination.

Some storage containers may contain toxic substances such as lead, or may react with foods and release toxic chemicals. Some plastics release toxic chemicals.

The main categories of chemical contamination include:

* insecticides or pesticides
* herbicides
* antimicrobial agents (antibiotics)
* growth promotants.

***Pesticides and herbicides***

Pesticides and herbicides may find their way into foods at high enough levels to cause problems if they are not used properly. Testing of foods, such as meat and other rural produce, is carried out routinely to ensure they remain below prescribed, safe levels. Careful use and correct storage of these dangerous compounds is necessary.

Meat is particularly susceptible to this, as the animal may eat off pastures that may have been treated with some pesticide or herbicide. This residue may then build up in the animal tissue and be retained for a considerable time. The level of residues are not likely to be hazardous to the consumer, but they may exceed regulatory standards or importing country requirements.

This is a particular problem for abattoirs, particularly export plants. The importing countries, such as the USA, Japan and the European Union (EU) have placed very stringent standards on the allowable level of residues in meat. Some of the common residues monitored are covered in the following paragraphs.

**Herbicides**

Herbicides are widely used by the pastoralist to control unwanted plants and weed in their pastures. These include common, patent herbicides such as ‘Round-up’ and ‘Zero’. More toxic herbicides also constitute a hazard to meat. The defoliant ‘Agent Orange’ is probably one of the most notorious of these. Dioxin-based ones are the most hazardous, as consumers affected by these would suffer serious illness, including neurological problems.

**Pesticides**

Similarly, animals grazing in pastures treated with insecticides may also develop high residue levels of these compounds. Chlorinated hydrocarbons such as DDT (which is now banned), endrin, heptachlor, etc. are sometimes detected. The problems come from earlier use as the residue stays in the soil. Cattle ingest the grass, storing the residue in their fat. If the residues are not combatted, they are potentially hazardous to the consumer.

Organophosphates, such as malathion and dichlorvos, are used against the more resistant insect pests such as certain species of beetles, cockroaches, etc. These can be particularly hazardous as they may build up to dangerous levels.

Recently there have been considerable problems from residue build-ups after animals have been fed cotton mulch waste containing insecticides.

***Antibiotics***

Antibiotics are used to treat or prevent various diseases. The illegal use in food animals or failure to observe correct withholding periods may lead to meat contamination and a potential hazard to the consumer.

The routine use of antibiotics in animals is now more strictly controlled. The level in meat of antibiotics such as Penicillin, Streptomycin, Erythromycin, etc. is closely monitored and meat found to contain excess levels may be rejected.

It is believed that the effectiveness of the prescribed antibiotics is reduced because human consumption of meat has increased the chances of the infective micro-organisms becoming resistant to the antibiotic.

Veterinary chemicals may have withholding periods (WHP) after treatment to ensure that animals presented for slaughter do not have violative residue levels. Because some importing countries have lower maximum residue levels (MRL) than Australia some veterinary pharmaceuticals may also have an export slaughter interval (ESI), which is generally longer than the WHP.

Producers sending stock to market or abattoirs are legally required to submit, with the stock, a vendor declaration attesting to the residue status of the animals.

***Growth promotants***

There has been an increase in the use of chemical compounds produced to mimic the effect of the naturally occurring growth hormones in cattle. These are referred to as hormonal growth promotants (HGPs). Although not considered to be a food safety hazard to humans in many countries (including Australia and USA), several of the countries we export to, including the European Union and Saudi Arabia, ban their use.

***Radiation hazards***

This is a new technique of food preservation, but it is not legal for use on food in Australia. But it is used overseas for certain foods.

Irradiation preserves food by the ionising radiation passing through the living cell and as it passes, electrons are ejected changing the atomic structure and thus killing the microorganism.

An important attribute of this type of radiation is that there is no residual radiation left in the food after treatment. So it is safe for the consumer. Great care needs to be taken by operators of the equipment, as the radiation is potentially lethal. Special facilities are used for treatment of food in the US.

The radiation of food has a relatively limited application at the moment, since most consumers are extremely wary of this technology. This process is currently only used commercially in Australia for the sterilisation of certain surgical materials that cannot be sterilised by other means.

The irradiation of meat is not permitted in Australia. Radiation of food in Australia is restricted to dried herbs and spices as an alternative to the dangerous fumigants used in the past.

**Note**: Radiation is considered contamination under both the Food Standards Code and The AS4696:2023 *Australian Standard for the hygienic production and transportation of meat and meat products for human consumption.*

**What control methods are used to minimise chemical hazards?**

The domestic and international reputation of Australia's meat as a healthy product, free from residues, is important to uphold. In order to protect the public health, as well as our valuable export market, Australia has implemented systems to strictly monitor and control the residue level in meat to minimise potential hazards.

To ensure meat remains safe and that chemical hazards are controlled we have put in place:

* Maximum Residue Limits (MRLs)
* withholding periods for drugs and chemicals including Export Slaughter Interval (ESI)
* National Residue Survey (NRS)
* Targetted testing programs
* A traceback policy.

***Maximum Residue Limit (MRL)***

The maximum residue limit is the maximum concentration of a chemical compound or residue permitted or recognised as acceptable in or on food. The concentration is expressed in milligrams per kilogram (PPM) of the commodity (or milligrams per litre in the case of a liquid commodity) unless otherwise specified.

The MRL is specified for different foods by the Australian New Zealand Food Authority in the *Food Standards Code*.

To look up the various residues, you should refer to Part A, sub section 14 of the *Food Standards Code*.

***Withholding period/Export Slaughter Intervals***

Apart from ensuring that the residue does not exceed safe levels, it is important to ensure that a safe period of time elapses from when the chemical first comes into contact with the food, to when the food is consumed. This period of time is referred to as the withholding period. This period allows the animal to excrete the chemical or the level to dissipate to safe levels. The manufacturer is responsible for ensuring the withholding period information is clearly set out on the label. It is essential to ensure that this period is strictly complied with before processing the meat for consumption.

All chemicals have withholding periods (WHP) after treatment to ensure that animals presented for slaughter do not have violative residue levels. Because some importing countries have lower maximum residue levels (MRL) than Australia some veterinary pharmaceuticals may also have an export slaughter interval (ESI), which is generally longer than the WHP.

Producers sending stock to market or abattoirs are legally required to submit, with the stock, a vendor declaration attesting to the residue status of the animals.

***National Residue Survey (NRS)***

The National Residue Survey was set up by the Australian government in the 1960s to monitor chemical residues in our agricultural goods, particularly meat.

It is important to note that it is a survey and not a test and hold procedure. With meat, sampling mostly occurs at the abattoirs. Analysis of the samples is undertaken by an independent body such as the Australian Government Analytical Laboratory (AGAL).

The products and chemicals selected for survey are based on many factors which can include:

* the extent of use of the chemical – if a chemical is no longer used, there is not much point doing expensive monitoring tests
* the potential for misuse
* whether or not it is likely to be used close to slaughter
* toxicity of the residue
* persistence of the residue
* the requirements of the client countries, e.g. the European Union is keen to have meat free of Hormonal Growth Promotants (HGPs).

***Targeted testing***

The Targeted Antibacterial Residue Testing (TART) program targets cattle and the Targeted Antibacterial Residue Testing (START) program targets sheep, which on veterinary inspection the On Plant Vet at export abattoirs suspects may contain antibacterial residues. The Program requires sampling of the targeted animal with the aim of determining a level of residue(s) to judge if the meat product from this animal is safe to enter the food processing chain, or if violative levels are detected, to require DAFF supervised disposal of the condemned carcase / meat product

The National Organochlorine Residue Management program was introduced to minimise the risk of cattle with organochlorine residues above the Australian MRL being slaughtered for human consumption.

Inspection staff may be alerted to a possible meat contamination issue if the Vendor Declaration that accompanies the animal to slaughter, indicates that a chemical or drug has been applied or that the property is under some restriction due to chemical contamination e.g. organochlorine contaminated properties.

It may also arise if there are indicators of treatment such as injection wounds, a dye in the udder, a chemical smell on the animal or unusual animal behaviour. The officer in charge of meat inspection is then expected to hold the affected carcases and test them prior to release for consumption

***Traceback policy***

The NRS monitors a wide range of residues and allows government agencies to carry out field investigation and quarantine affected areas or properties using data collected from the NRS. Data collected from this and other programs has allowed Australia to establish an effective and efficient traceback policy on residues. This ensures there is a system in place that identifies and controls problems when they are detected.

**What control methods are used to minimise allergen hazards?**

Dependent upon the allergens present in the workplace and where they are used, many value – added meat processing plants follow some of all of the steps below to control allergen cross – contamination:

* production scheduling, i.e. make the allergen containing product last
* conducting a full clean between batches and production runs
* ensuring staff adhere to GMP at all times, i.e. changing aprons and gloves when entering processing room
* using dedicated staff to make the product
* using dedicated processing and packing equipment
* making the allergen based product in a dedicated room
* using unique cleaning equipment to the production room or for the allergen.

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| **Activity suggestion two: Chemical contamination of meat**  **Materials and specialist personnel**  Competent meat inspector, company QA manager.  Cattle/sheep producer.  Copies of regulatory requirements relating to chemical contaminants, allergens and residues in meat.  Testing schedules and procedures, sampling plans.  Animal identification and traceback systems e.g. electronic tags.  Access to laboratory/testing area.  Access to plant.  PPE  Access to the internet.  **Method**  Discuss the chemical contaminants found in animals, including agricultural and veterinary chemicals and the chemical contamination of meat that may occur on plant.  Invite the QA manager to discuss the financial implications of chemically contaminated meat, e.g. loss of markets and the threats to public safety.  Explain the regulatory requirements relating to chemical contamination of meat.  Discuss monitoring programs for chemical contamination, including the National Residue Survey (NRS) and the Hormonal Growth Promotant (HGP) status requirements.  Tour the lairage and slaughter floors, chillers and load out. Again make sure the trainee is wearing appropriate PPE and observes hygiene and safety requirements. As you tour the shed, point out where animal tags are identified, recorded and monitored, including how the carcases and carcase parts are correlated. Examine tags and relevant records.  Also while touring the plant, identify possible chemical contaminants, e.g. cleaning and sanitising products, machinery lubricants, pesticides. Discuss the procedures for minimising and controlling these hazards.  **Trainee activities**  Ask the trainee to research chemical contamination of meat and prepare a critical report on the agricultural and veterinary chemicals used in the husbandry of animals for human consumption. The report should include a review of the beneficial negative impacts of the chemicals on animal health, and the potential impact on human health, if contaminated meat is consumed. Encourage the trainee to also identify controls for, and alternatives to, the use of these chemicals.  Investigate the allergens present in value-added products made in the workplace along with related SOPs, GMP and control measures in place. List the allergens present and obtain a copy of a product label or specification.  Suitable websites include:   * www.foodstandards.gov.au * www.mla.com.au * www.daff.gov.au   The report could be formal and presented to the group or the research could be used in a general discussion with the QA manager, the meat inspector and the livestock producer.  Go to the area of the abattoir/farm/home where chemicals such as insecticides, herbicides or antibiotics are kept. List five of them and include: the trade name, the chemical name and the withholding period. |

**Physical hazards on meat**

**What are the physical hazards for meat and meat safety?**

Physical hazards are defined as foreign objects that are accidentally introduced into food, or when naturally occurring objects, such as bones in fish or meat, are present and can pose a threat.

Examples of common physical contaminants include:  metal shavings from cans, metal particles from rusty equipment, staples from cartons, glass from broken light bulbs, fingernails, hair, bandages, dirt, and bones.

A physical hazard can enter a food product at any stage of production. Hard or sharp objects are potential physical hazards and can cause cuts to the mouth or throat, damage to the intestines and damage to teeth or gums.

Some physical hazards can carry potentially dangerous microorganisms e.g. hair and wool dust on dressed carcases.

Other physical hazards are largely aesthetic issues for the consumer such as human hair or fingernails in food at retail.

**What are some common physical hazards?**

The main types of physical hazards in food include:

* glass: common sources found in food processing facilities are light bulbs, glass containers and glass food containers
* metal: common sources of metal include metal from equipment such as splinters, blades, broken needles, fragments from worn utensils, staples, etc.
* plastics: common sources of soft and hard plastics include material used for packaging, gloves worn by food handlers, disposable aprons, bag liners, utensils used for cleaning equipment or from tools used to remove processed food from equipment
* stones: field crops, such as peas and beans, are most likely to contain small stones picked up during harvesting. Concrete structures and poorly maintained floors in food processing facilities can also be a source of small stones
* wood: common sources of wood come from wood structures and wooden pallets used to store or transport ingredients or food products.

Some particular physical hazards that may be found in meat include:

* hair and wool: as a result of poor dressing techniques
* wool dust: from processing sheep
* bone chips and pieces: left in meat during boning.

**How can physical hazards be controlled and prevented?**

When undertaking your risk analysis for your HACCP plan, you can classify physical hazards into three classes depending on their likelihood and the severity of the consequences:

* Category I (high likelihood) such as glass or sharp bones
* Category II (moderate likelihood) pieces of cartilage in meat
* Category III (low risk) such as human hair.

Every food process has its own specific and potential hazards. Evaluation of the type of product, the intended market for the product and other factors need to be considered to determine the risk category for physical hazards.

The DAFF carton meat assessment system is a three-class system for monitoring organoleptic/physical defects in meat.

To develop an effective physical hazards identification and control program, detailed information for every step of every process in the plant needs to be collected.

Information on potential sources of physical hazards can be obtained by closely observing each process during all phases of its operation as part of the hazard analysis process.

There are many ways physical hazards in food products can be prevented, including:

* inspecting raw materials for contaminants e.g. hair on carcases entering the boning room
* following good storage practices and evaluating potential risks in storage areas e.g. sources of breakable glass such as light bulbs, staples from cartons, etc. and using protective acrylic bulbs or lamp covers
* developing specifications and controls for all ingredients and components, including raw materials and packaging materials. Specifications should contain standards for evaluating acceptability of ingredients or packaging materials e.g. recycled cardboard used for packaging sometimes contains traces of metals that can be detected by metal detectors.
* setting up an effective detection and elimination system for physical hazards in your plant such as metal detectors or magnets to detect metal fragments in the production line, filters or screens to remove foreign objects at the receiving point
* regularly maintaining the equipment in the plant to avoid sources of physical hazards such as foreign materials that can come from worn out equipment
* regular employee training on shipping, receiving, storing, handling, equipment maintenance and calibration will also help prevent physical hazards from being introduced into food products
* ensuring employees adhere to personal hygiene and sanitation rules such wearing hair and beard coverings and not wearing rings or uncovered earrings etc.

In addition there are several methods available to detect foreign bodies in food on processing lines, but most are too expensive for use other than in large processing plants.

Metal detectors will detect metal in food products. They should be set up to reject products from the food production line if metal is detected. Proper maintenance should be given to this equipment to ensure they are always accurate and don’t produce false positives.

Magnets can be used with metal detectors on food production lines to attract and remove metal from products. This does not work well with meat.

X-Ray machines can be used on food production lines to identify hazards such as stones, bones and hard plastics, as well as metal.

Food radar systems transmit low-power microwaves through food products to identify foreign bodies such as metals, plastics, bones, kernels and organic materials in food on production lines.

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| **Activity suggestion three: Physical contamination of meat**  **Materials and specialised personnel**  Copies of relevant regulatory requirements.  Relevant work instructions and SOPs.  HACCP plan.  Monitoring data.  Access to different areas of the plant, e.g. holding pens, knocking box, slaughter floor, chillers and freezers, boning room, packing.  PPE  Videos, e.g. *Food poisoning – the choice is yours* and *Keep it clean*.  Supervisors and competent operators in different areas of the plant, quality assurance personnel, meat inspectors, HACCP team leaders.  **Method**  Review the regulatory requirements relating to the physical contamination of meat.  Brainstorm the range of physical contamination hazards to be found around the plant, e.g. hide roll back during dressing. Select several examples and discuss how the relevant work instruction or SOP incorporates regulatory requirements. Also identify any control measures or corrective actions. Show how the work instruction links to the HACCP plan, if appropriate.  Invite the HACCP team leader for a particular product/process, or the QA manager, to explain how physical contamination hazards have been identified, assessed and incorporated into the HACCP plan.  Take the trainee on a tour of the plant. Make sure they are wearing appropriate personal protective equipment and are familiar with the hygiene requirements of the different areas that are visited. Also explain the safety requirements that must be followed. As you tour the plant, ask the trainee to identify the physical contamination hazards and any preventative or corrective measures observed.  In the training room, discuss the trainee’s observations and, if necessary, call upon supervisors or quality assurance personnel to answer any questions.  **Trainee activities**  Ask the trainee to select an area of the plant and conduct a physical contamination study. Ask the trainee to:   * describe the product or process under study * identify physical contamination hazards * control measures for each hazard * analyse supporting documentation, including SOPs and work instructions * analyse any monitoring data to determine the effectiveness of the control measures.   The trainee should gather quantitative and qualitative information and may need to talk with competent operators, HACCP team leaders, Quality Assurance personnel and supervisors.  The information gathered in this project is to be put into a written report. |

**Calibrate thermometers**

**What types of thermometers are used on meat processing plants?**

There is a range of thermometer designs. The most common in use at meat processing plants are:

* liquid in glass thermometers
* spear
* digital
* infrared
* temperature labels.

***Liquid in glass thermometers***

These are now rarely used, as they are delicate and easily damaged. When a glass thermometer is made the glass is in a highly stressed state. This stress relaxes with time and the bulb contracts. Contraction is quite rapid at first but decreases with time. The change is known as the ‘secular change’. NATA recommends checking liquid in glass thermometers a minimum of every six months.

Before calibrating a liquid in glass thermometer it should first be inspected for defects such as:

* bubbles trapped in the bulb
* breaks in the liquid column
* uneven graduations and
* faults in markings.

Liquid in glass thermometers should never be used in processing areas – a broken mercury in glass thermometer may pose an injury or health hazard if product contamination occurs.

***Spear thermometers***

These thermometers are based on the principle that all metals expand when heated, and the amount of expansion depends on the temperature and the coefficient of expansion.

A common version is the ‘Teltrue’ with a dial face.

***Digital thermometers***

Digital thermometers are cheap and remarkably accurate. The probe in most of them operates on the principle of detecting the minute electric current that passes between two dissimilar metals and the variation in this current as the temperature varies.

Digital thermometers can be calibrated but generally the readings cannot be altered. Variations are noted on the thermometer, e.g. + or -1°C.

Calibrated accurate digital thermometers make good reference thermometers.

***Infrared thermometers***

This type of thermometer is designed only for the testing of surface temperatures. It is very easy to operate, just aim at the meat and pull the trigger and you get an immediate reading. It operates by identifying the radiant heat from a body. The device emits a small laser light that helps to identify the target area. They have the drawback that they take some minutes to adjust for the ambient temperature in the room where the product is to be tested and the measurement varies with emissivity of the surface e.g. dark surfaces will record as being warmer than light surfaces.

A common problem is that they measure the surface of a carton and this can become quite warm during loading operations without affecting the temperature of the meat inside.

For greatest accuracy, these should be used in an ambient temperature close to that of the product being measured and after the surface has had time to equilibrate with the ambient temperature e.g. chiller or freezer.

Measurement with these devices should be regarded as a **guide** rather than an ultimate accurate reading

***Temperature labels***

These are labels that change colour when a certain temperature is reached. They are used in autoclaves for the sterilisation of instruments and in retorts to indicate if the correct temperature has been reached to kill all relevant organisms. They are also used in the transport of refrigerated product to indicate if there has been any temperature abuse during transport.

They are single use only and cannot be reused.

They are set and pre-calibrated by the manufacturer.

**How is the calibration of thermometers performed?**

To calibrate the thermometer you need to provide an environment of known temperature. The best way of doing this, and the method specified by NATA, is to use ice point.

**Water doesn’t always boil at 100°C!!!**

It is often assumed that water always boils at precisely 100°C. This is not correct. The boiling point varies with air pressure, the purity of the water and the type of container it’s being boiled in. Depending on the accuracy required in your workplace boiling water may not be acceptable for calibration.

**Ice point**

The freezing temperature of water does not vary as much as its boiling point. A properly prepared ice-point can be reproduced to within 0.001°C.

***Reference Thermometers***

In addition to the thermometers used in the laboratory and in the plant every laboratory should have a *reference thermometer.* These are calibrated by NATA accredited laboratories and come with a calibration certificate.

Reference thermometers are only used for calibrating other thermometers and should not be used for taking measurements on a day to day basis as this will quickly reduce their accuracy.

***Calibration methods***

There are three main methods of calibrating thermometers:

* the NATA fixed two-point method (0°C & 100°C)
* the Food Science Australia method (DAFF recommended)
* automated calibration.

**The NATA fixed two-point method for calibrating thermometers**

* mix crushed ice and water in a vacuum flask. ensure that the ice fills the container top to bottom
* leave for 5 minutes
* insert thermometer to be calibrated and the reference thermometer. make sure they are both well in the ice slurry
* swirl the mixture for 1 minute
* after 3 minutes compare the thermometers.

**Note***:* any variation between the thermometers and record it.

For a two-point calibration you would repeat this process using boiling water. Make sure that both thermometer bulbs are close to each other and are away from the bottom and sides of the container.

**Non-fixed two-point calibration (FSA/Department of Agriculture recommended)**

By using a reference thermometer as the standard instead of the ice-point and the boiling point a more practical method as described by Food Science Australia in the document “Calibration of the temperature logger” can be used.

In this method a two-point calibration is achieved with both calibration points near the thermometer at which the temperature is to be used.

The cold point should be about 7°C and the hot point about 80°C.

The procedure is as follows:

**Equipment**

* insulated container e.g. vacuum flask or small esky
* cold water / hot water
* reference thermometer- NATA calibrated
* laboratory stand to hold thermometers
* labels, book and pen.

**Procedure**

1. Fill the container with the water at about the required temperature.
2. Insert the reference thermometer and the working thermometer(s) to be calibrated into the water to the required depth and fix them into position with the clamps on the stand. Ensure that they do not touch the sides or the bottom of the container.

The required depth of immersion should be as marked on the thermometer or as detailed in the instruction manual for the thermometer.

Mercury thermometers must be readable with the top of the mercury column at eye level to avoid parallax errors.

Do not lift the thermometers out of the water to read them.

1. Allow the thermometer to reach a steady reading. This reached when there is no difference between two successive readings taken one minute apart. Temperature loggers without a display can be seen at one minute intervals.
2. Note the temperature of the reference thermometer and record it on the calibration records sheet and apply any correction identified on the calibration certificate.
3. Record the identification of each working thermometer on the calibration record sheet.
4. Record the temperature of each working thermometer.
5. Record the difference between the reference thermometer and each working thermometer. The temperature of the working thermometer must be subtracted from the reference thermometer. This will produce a negative number if the working thermometer is reading greater than the reference thermometer.
6. Write the correction for each thermometer on a tag attached to the thermometer.
7. Write the date of the calibration on the tag.
8. Repeat the process for the second calibration point.

**Corrections**

Corrections are the difference in readings between the reference thermometer and the working thermometer.

The corrections may be positive or negative.

Corrections are always added to the temperature reading. For example:

|  |  |  |
| --- | --- | --- |
| **Reference temperature** | **Working thermometer temperature** | **Correction** |
| 82.2 | 82.7 | -0.5 |
| 0.0 | -0.2 | 0.2 |
| Reading of working thermometer | Correction | True reading |
| 83.7 | -0.5 | 83.2 |
| 0.2 | +0.4 | 0.6 |
| -0.3 | +0.4 | 0.1 |
| -0.3 | -0.3 | -0.6 |

**Adjustable thermometers**

Some thermometers can be adjusted to read the correct temperature. If it is easy to do so, it should be done, but if it is difficult a correction label should be applied instead.

**Note**: adjustable thermometers can only be corrected at one temperature. It may be out and require a correction at the second point.

**Automated calibration**

There is at least one machine available for automated calibration of thermometers. The main one available in Australia can do up to twelve thermometers in four minutes at 0°C and 100°C without the use of boiling water.

It is thus much better from an WHS point of view.

It is capable of calibrating a range of thermometers including probes, infrared and surface thermometers. It is accurate to 0.1°C.

**HACCP based Quality Assurance systems**

**What is HACCP?**

HACCP is the acronym for Hazard Analysis Critical Control Point and is a critical part of Australia’s meat industry food safety system. It is pronounced ‘Hassep’ and based upon a CODEX guideline. (Codex Alimentarius General Principles of Food Hygiene (CXC 1-1969))

The HACCP concept is a systematic approach to the identification and assessment of hazards and risks associated with the production, processing, distribution and use of a particular foodstuff.

There are regulations and codes of practices/guidelines that cover HACCP and food safety at the International, Federal, State and Local levels.

Often HACCP is integrated with Quality Assurance programs. This is especially the case with SQF, BRC and various vendor standards.

**What regulations and standards govern the meat industry?**

There are minimum mandatory standards for the meat industry. The Agricultural Resource Management Council of Australia and New Zealand (ARMCANZ) with the Standing Committee on Agriculture and Resource Management (SCARM) and have endorsed thestandard AS4696 2023.

In addition to developing these *Australian Standards*, ARMCANZ decided that all meat processing establishments in Australia would be required to have Hazard Analysis Critical Control Point (HACCP) based Quality Assurance (QA) systems.

Some of the regulations and bodies governing the processing and manufacture of meat and smallgoods are:

* the Food Standards Australia New Zealand (FSANZ) *Food Standards Code*
* State and Federal meat authorities
* Departments of health
* State departments of primary industry
* Departments of consumer affairs
* the Department of Agriculture, Fisheries and Forestry (DAFF)
* *Australian Standards* (ANZFRMC/FRSC standards).

When developing a HACCP plan it is important to identify all of the regulations relating to the product and processes being considered in the plan.

Food safety requirements for all meat processing in Australia are based on the Australian standards. The main one for abattoir-slaughtered meat is:

TheAS4696:2023 *Australian Standard for the hygienic production and transportation of meat and meat products for human consumption*

For poultry the standard is:

*“The Australian Standard for the Construction of Premises and Hygienic Production of Poultry Meat for Human Consumption.”*

For ratites (emus & ostriches) the standard is:

*“The Australian Standard for the hygienic production of ratite (emu & ostrich) meat for human consumption.”*

For game the standard is:

*“The Australian Standard for the hygienic production of game meat for human consumption.”*

For crocodiles the standard is:

*“The Australian Standard for the hygienic production of crocodile meat for human consumption.”*

For rabbits and hares the standard is:

*“The Australian Standard for the hygienic production of rabbit meat for human consumption.”*

In addition there is a new processing standard for meat in the *Food Standards Code* (Standard 4.2.3) that applies to all meat processing and is consistent with all the above standards (https://www.foodstandards.gov.au/food-standards-code/proposals/proposalp1005primary4220).

**What is an Approved Arrangement?**

All the relevant regulators require meat processors require operators to have an Approved Arrangement with the relevant controlling authority.

State and Territory meat authorities are the controlling authorities for domestic plants and DAFF is the controlling authority for export-registered plants.

**Note**: The *Export Control (Meat and Meat Products) Rules 2021* uses the AS4696:2023 *Australian Standard for the hygienic production and transportation of meat and meat products for human consumption* as the basis for food safety issues on export-registered plants.

The Rules do not cover food safety issues, but call up the Australian standard for this purpose. The orders mainly cover certification issues such as product integrity and overseas country requirements.

Note: The *Game Poultry and Rabbit Meat Orders* call up the other relevant *Australian Standards* as the basis for food safety issues on export-registered plants.

Approved Arrangements must be based on HACCP. But there is no requirement for them to be based on ISO standards.

A set of guidelines has been drawn up to show how an Approved Arrangement should be drawn up. These guidelines are broadly based on the previous Department of Agriculture Meat Safety Quality Assurance (MSQA) guidelines and are generally consistent with the ISO standards which are:

* ISO/FDIS 22000(2005) Food Safety Management Systems- Requirements for organizations throughout the food chain.
* ISO 9001: 2008 Quality Management Systems-Requirements.

In order to be approved by Department of Agriculture the scope of the Approved Arrangement must cover all operations from the receival of livestock to export.

A HACCP based QA system that is an Approved Arrangement consists of the following main elements.

* Management responsibilities and procedures – which provide for management commitment and control including internal audit and management review.
* Process control– which includes pre-requisite programmes based on Good Hygienic practices and HACCP, based on the Codex guidelines.
* Product Integrity and Certification procedures –These only apply on export-registered plants.

The “Approved Arrangement” guidelines require the QA systems of export meat processing plants to address the following issues:

**System Commitment**

* Policy objectives and commitment.
* Organisational structure.

**System Support**

* Internal audit.
* Management review.
* Corrective action.
* Training.

**Process control**

Process steps based on Good Manufacturing Practices (GMP) work instructions.

Standard Sanitary Operating Procedures:

* Plant sanitation.
* Personal hygiene.
* Vermin control.
* Water quality.
* Chemical control.
* Waste management.
* Refrigeration.
* Maintenance.
* HACCP.
* Calibration.
* Laboratory testing.
* Animal welfare.

**Product integrity/ certification**

* Product identification and traceability.
* Product withdrawal and recall.
* Product description.
* Export security and integrity.
* Control of official marks.
* Overseas country requirements.
* Export documentation.

Many of the above points are also described as pre-requisite programs. They do not refer to a specific process steps but support the implementation of a HACCP based QA program.

The final system structure will often depend on:

* customer requirements – e.g. food safety specifications, third party certification such as Lloyd’s Register Quality Assurance
* regulatory requirements – e.g. DAFF, FSANZ and state meat authorities
* importing country requirements
* company objectives for food safety.

For example product integrity/certification has little relevance for domestic meat operators. Some customers may require QA systems based on the ISO 9000 standard.

Note: The Department of Agriculture Approved Arrangement guidelines are broadly consistent with the various ISO 9000 Quality system standards.

**What are the minimum elements of a HACCP based QA system?**

There are a number of QA system elements that are used to support HACCP systems. The choice rests on the needs of stakeholders. In general, the following should be seen as minimum system content of any HACCP based QA system.

* Management control systems.
* Prerequisite programs.
* HACCP.

***Management elements***

These are:

* management commitment as expressed in policy documents
* management structure and responsibility
* training and verification procedures.

***Prerequisite programs***

The production of safe food requires that the HACCP system be built upon a sound foundation of pre-requisite programs. These pre-requisite programs are designed to control the processing environment and food handlers as a source of contamination in the production of safe food.

Sufficient prerequisite programs should be developed to make sure that hazards associated with the environment in which the process is conducted are controlled.

Generally in the food industry, the following minimum procedures are developed:

* water
* pests and rodents
* chemicals and food additives
* personal hygiene
* cleaning and sanitation
* waste disposal
* calibration.

Since Prerequisite Programs play a major role in underpinning a HACCP system by providing control measures, it is essential that they are validated to demonstrate their effectiveness as control measures.

There are guidelines for validation of food hygiene control in Codex.

***Good Hygiene Practice (GHP)***

The requirements for GHP are that food safety hazards identified during hazard analysis as not being critical, but still important, and regulatory requirements not addressed by other system elements should be controlled through GHP.

Examples of the control of hazards include for example ensuring workers clothing do not cross contaminate the product with the supply of disposable aprons and hose down facilities in ante rooms and by specific work stations.

Note that some plants may refer to the term Good Manufacturing Practice (GMP) instead of GHP as it addresses not only personal hygiene but also a number of other areas such as cleaning and sanitation, staff movement, dropped product through to foreign object control.

***HACCP system***

The HACCP system elements are:

* the five preliminary steps
* the seven HACCP principles.

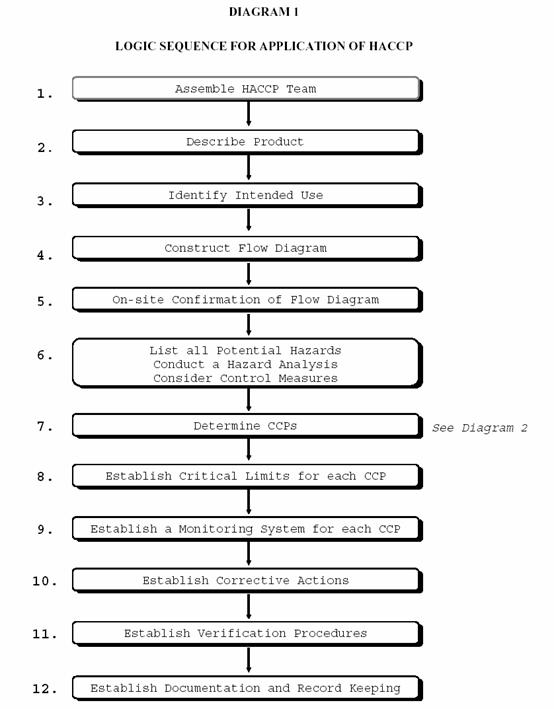
**How should HACCP be introduced and implemented?**

The introduction and use of the HACCP system in any sector of the food industry involves the following basic sequential steps:

* preparing for the introduction of HACCP
* preparing a process flow chart
* conducting a HACCP study involving the seven principles
* implementing the HACCP plan
* maintaining the HACCP plan.

There are some basic actions required before the seven HACCP principles can be applied.

The following diagram (from Codex) shows an outline of the steps for the development of a HACCP plan.



Source: Codex Alimentarius-Hazard Analysis and Critical Control Point (HACCP) System and Guidelines for its Application, (Annex to CAC/RCP 1-1969, Rev. 4-2003).

**What are the seven HACCP principles?**

At present most HACCP systems consists of seven basic principles that outline how to establish a HACCP plan. The Codex format is listed below:

**Principle 1**

Conduct a hazard analysis.

**Principle 2**

Determine the Critical Control Points (CCPs).

**Principle 3**

Establish critical limit(s).

**Principle 4**

Establish a system to monitor control of the CCP.

**Principle 5**

Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control.

**Principle 6**

Establish procedures for verification to confirm that the HACCP system is working effectively.

**Principle 7**

Establish documentation concerning all procedures and records appropriate to these principles and their application.

HACCP is a process control system that aims to control food safety hazard(s) associated with the food product, its ingredients and process (from arrival of raw material, through processing to finished product).

The HACCP system is not designed to control peripheral hazards such as:

* personal hygiene of food handlers that are incorrect
* cleaning and sanitation regimes that are ineffective
* inadequate pest control measures
* inadequate maintenance measures for the processing.

These potential food safety hazards are best controlled through the development, implementation and maintenance of pre-requisite programs or Standard Operating Procedures (SOP).

HACCP relies on a systematic approach of documenting and analysing each step in the manufacturing process to identify where actual or potential hazards to food safety may exist. Once the hazards have been identified, measures are put in place to control them.

Food safety hazards include:

* biological including microbiological hazards
* chemical hazards including allergens
* physical hazards.

Sources of hazards include raw materials, the processing equipment, the staff, processing procedures, handling procedures, storage conditions, etc. as covered in the earlier parts of this training module. The key goals of HACCP are:

* identification of all sources of hazards to food safety
* the development of procedures and controls to eliminate or reduce hazards.

**How is a HACCP system developed?**

A HACCP system is developed by applying the five preliminary steps and seven principles of HACCP as in the Codex diagram on page 73.

References and resources that should be consulted include:

Codex Alimentarius - *Codex Alimentarius Alinorm 97/13A, Appendix II*

[www.codexalimentarius.net](http://www.codexalimentarius.net)

*HACCP alliance website* <http://haccpalliance.org>

*FSIS HACCP website* – <http://www.fsis.usda.gov>

*NEW Zealand Food Authority*- [http://www.nzfsa.govt.nz/animal products/haccp/index.htm](http://www.nzfsa.govt.nz/animal%20products/haccp/index.htm)

*Canadian Food Inspection Agency* – <http://www.inspection.gc.ca>

*A Guide for the Preparation of Approved Arrangements-* Department of Agriculture.

Andriessen E.H., 2006, *Meat Safety Quality and Veterinary Public Health in Australia, eighth edition*

**How are the preliminary steps to introducing a HACCP system implemented?**

***Step 1: Assembling the HACCP team.***

The importance of a team approach cannot be overstated. This element of the development phase will, to a large extent, dictate the validity of the outcomes.

The number of people on the HACCP team will depend on the size of the organisation. As many people as practicable should be involved, ideally from all areas within the workplace. In large organisations there will be too many people in a particular process to involve everyone in the development of the HACCP plan. When this situation occurs, it is essential that those not involved are made aware of what is going on, and are given an opportunity of having input into the process.

Having senior management actively supporting the development team will reinforce the importance of the HACCP process.

Scope and terms of reference should be established

HACCP team leader needs to be appointed and appropriately trained.

***Skills and knowledge requirements***

People who need to be involved may include the QA manager, staff, supervisors, engineers, dispatch, senior management and key people from the production line. Regardless of the number of people involved, it is very important that the HACCP team includes individuals who have a good understanding of:

* the HACCP process
* food/meat manufacturing
* food/meat microbiology
* stakeholder needs.

Team members must also have knowledge of the products manufactured in the plant and the equipment and processes used to make them.

All team members should receive training in the basic principles of HACCP.

Only once the team has been selected and trained can the process move to the next step.

HACCP team must be trained – minutes of HACCP team meetings should be kept as a record of HACCP development and maintenance.

***Steps 2 & 3: Describe the product and its intended use***

When developing a HACCP plan, it is necessary to describe the food, its method of distribution, its intended use and who will consume it.

This will enable you to develop an appropriate risk profile that takes into account any hazards that exist in the product and/or packaging materials. It will also highlight any areas, such as special handling considerations, that may need to be included for the particular product.

The first part of this process is to develop a profile of the products and raw materials. It may involve listing all raw materials by type and condition, e.g. boneless frozen meat.

The second part of the process is to describe the product, its method of distribution including the intended use, and the consumers of the food.

A typical example is presented below.

|  |  |
| --- | --- |
| **Product description and intended use** | |
| Common name: | The common name of the product e.g. diced pork, ground beef, etc. |
| How it is to be used: | Describes how the consumer must store, handle and prepare the product for consumption |
| Packaging – primary: | Indicates the type of packaging the actual product is contained in, e.g. vacuum bags |
| Packaging – secondary: | This is the outer container for individual packaged units, e.g. clean cardboard cartons |
| Shelf life: | This relates to the effect time and temperature has on the product: 3 months at 0oC or below, 14 days at 0–4oC |
| Distribution methods: | This describes how the product will be delivered to customers, e.g. refrigerated van at 0–4oC |
| Sensitive customer: | This usually refers to the young, the elderly, pregnant women, immune-compromised and the infirm.  Food allergens may also be included here i.e. product contains wheat and soy. |
| Labelling instructions: | This is how the product is to be labelled, including:   * keep frozen * thawing instructions * safe food handling label * cooking instructions. |
| Microbiological standards | Specify customer requirements. |

***Step 4: Construct flow diagram or chart***

If a HACCP plan is to be effective, **all** parts of the process must be reviewed so that all hazards associated with the product can be identified.





In the case of an integrated meat establishment, the process steps may include:

* raw material – livestock.
* manufacture – slaughter, chill, bone and refrigerate
* output – refrigerated product despatched from the plant.

This process is broken down into its component parts and the process flow diagram is used to provide a simple description of each step involved in the process. The diagram is essential in assisting the HACCP team in determining the presence of hazards in the process. It will also serve as a future guide for auditors who must understand the process for their verification activities.

The flow diagram must cover all the steps in the process that are directly under the control of the organisation. The flow diagram should consist of symbols and words, not complicated engineering drawings.

While there are a number of internationally recognised symbols for developing process flow charts organisations may choose to develop their own. Some common sense rules associated with developing process flow charts are:

* keep it simple
* limit the side branches to those essential for clarification
* number each step – this is essential to assist cross referencing to work instructions/GMP or the HACCP plan
* provide a brief description of each step
* don’t use arrows.

Below is an example of a process flow chart.



1. Receive & inspect cartons of meat.
2. Weigh product.
3. Transfer to chiller.
4. Chiller storage.
5. Load out – inspect – unpack.

***Step 5: Confirm accuracy of flow diagram***

The flow diagram must fully reflect the process. It is best developed on site using the people responsible for the process. It is essential to confirm the draft flow chart developed in step four, against the **actual** process to ensure all steps are covered. An effective means of confirming the flow chart is to have the team walk through the process, to ensure that each step undertaken is included.

Once the flowchart has been confirmed, the team leader or other nominated person should sign and date the flow chart. This ensures that only the accurate flow chart is used for further analysis.

**What records of the five preliminary steps need to be kept?**

All documentation associated with the five preliminary steps should be maintained in an orderly file. This allows a logical path to be followed through the decision making process. Auditors will usually look at this information when assessing the decision-making processes.

It is also an essential resource to have available when validating or reviewing the HACCP plan.

**How are the HACCP principles applied when developing a QA system?**

To develop a HACCP-based QA system the seven principles need to be applied to the operations described during the preliminary steps. The following methods based on the system described in the “MLA Quality Assurance disc” should be followed.

**Principle 1 – conduct a hazard analysis**

A structured approach to hazard analysis is crucial to ensure that all hazards have been identified. The process is aided by having personnel from a wide range of disciplines in the HACCP team working from the verified process flow diagram.

The HACCP team should list all the potential and real hazards that may occur at each step in the process and assess the risks and severity of the hazards identified.

Here are some example questions to consider when defining hazards.

* Does the food contain any sensitive ingredients?
* Does the food permit survival or multiplication of pathogens or toxin formation during processing?
* Does the process include a controllable processing step that destroys pathogens?
* Is it likely the food will contain pathogens and are they likely to increase during the normal time and conditions under which the food is distributed and stored prior to consumption?
* What product safety devices are used during processing to enhance consumer safety (e.g. metal detectors)?
* What ‘hurdle’ factors (e.g. nitrite, pH) are incorporated in the product to minimise pathogen growth?
* Does the method of packaging affect the multiplication of pathogens and/or formation of toxins?
* Is there epidemiological evidence that the product is linked to a foodborne disease or outbreak?
* What technical and scientific papers have been written about safety risks in the product? These documents may need to be referred to satisfy critical limits.

Following identification of the hazards, they are assessed on two factors – Likelihood and severity.

**Likelihood**: relates to the likelihood of the occurrence of a hazard (i.e.: the probability that it will occur every time or one chance in a million).

**Severity**:  relates to the magnitude of a hazard (i.e.: how many people will get sick or what will be the liability costs). It is preferable that this assessment be quantitative rather than qualitative and requires considerable technical expertise.

For the purposes of HACCP in a meat processing plant, hazards can be considered as anything biological, chemical or physical in a food that could contaminate the food.

A hazard analysis is a review of a process or operation to identify any potential or actual hazards and, once identified, prioritise those hazards according to the risk they pose to consumer health.

There are four parts to a hazard analysis:

* document the potential hazards for each step identified on the flow chart
* document the actual hazards for each step identified on the flow chart
* evaluate the risk - supply evidence of how you do this, for example through tests or scientific evidence
* establish control measures for the significant hazards.

***(a) Document the potential hazards for each step identified on the flow chart***

* Check the product description to identify how this information could affect the hazard analysis as in preliminary step, i.e. have specifications for the hazards under consideration been specified? Will the packaging or raw ingredients introduce hazards?
* Review the intended use of the products, as in preliminary step, i.e. is the product to be subjected to further processing or will it be consumed in its finished form? Is the product specifically intended to be sold to high risk consumer groups?
* Determine if a biological, chemical or physical hazard exists at each step in the process flow diagram developed in preliminary steps, by answering the following questions:
* could the product be contaminated in this step? For example, by handling contaminated equipment or materials, cross-contamination from raw materials, water overspray, etc.?
* could pathogens multiply to the point where they become a hazard, for example, product temperature, hold time, etc.?
* could an ingredient, work in progress, or finished product become contaminated with pathogens?
* could this step introduce a chemical hazard to the product?
* could this step introduce a physical hazard to the product?
* Fully describe the hazards identified at each step.
* Find out the following information about the product/process:
* could the addition/use of rework cause a hazard?
* will the water activity of the finished product affect microbial growth?
* should the product be kept refrigerated during transit or in storage?
* are there any chemical or physical hazards associated with packaging materials?
* Fully describe the hazards identified.

***(b) Document the actual hazards for each step identified on the flow chart***

The second step involves reviewing the actual operations in the workplace.

* Observe the actual operation associated with the hazard to ensure that it is the usual process or practice.
* Review work practices where raw or contaminated product could cross contaminate other materials/products via hands, gloves or equipment used for finished products.
* Observe product-handling procedures for potential cross-contamination, including reviewing traffic patterns – people and equipment – in the establishment.
* Check workplace records for any past incidents of physical, biological, or chemical contamination to determine the cause, seriousness and the frequency of the contamination.

When all steps of the hazard analysis have been completed, transfer the available information to a Hazard Analysis working sheet (or your equivalent). The forms you use will depend on the type of products and the processes used to manufacture them.

***(c) Evaluate the risk***

After the lists of hazards have been assembled they should be evaluated to determine **significance.** This is the process of separating the important few from the trivial many. The use of a risk-rating model is an aid to objectivity during this process. The Standard AS/NZS/ISO 4360:2004 *Risk Management* offers the best risk-rating model and is the risk-rating model most commonly used in developing HACCP plans in Australian meat plants. Note: there are many variations of this model. You and your company should pick the one that suits your circumstances.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Likelihood** | | | | |
| **Severity** | **A** | **B** | **C** | **D** | **E** |
| **1 Fatality** |  |  |  |  |  |
| **2 Serious illness** |  |  |  |  |  |
| **3 Product recall** |  |  |  |  |  |
| **4 Customer complaint** |  |  |  |  |  |
| **5 Not significant** |  |  |  |  |  |

**Key:**

|  |  |
| --- | --- |
|  | Significant hazard |

**Likelihood**

**A** Common repeating occurrence

**B** Known to occur or it has happened (own information)

**C** Could occur or I’ve heard of it happening (published information)

**D** Not expected to occur

**E** Practically impossible

These are the risk ratings to be used to determine the significance of the hazards

***(d) Establish control measures for the significant hazards***

Preventative measures can be defined as any ‘*physical, chemical, or other means used to control an identified food safety hazard.*’

Typical measures for preventing chemical hazards include:

* sourcing raw materials from suppliers who process under an approved QA/HACCP system
* statistically based sampling and testing of raw materials at receival
* ensuring all chemicals used in the plant have detailed product specifications
* management of vendor declaration for the chemicals being fit for purpose and having regulatory approval where necessary
* properly labelling fitness for purpose, decanting and storing all chemicals
* properly training employees who handle chemicals
* maintaining up-to-date procedures for the use and handling of chemicals.

Typical methods for reducing physical hazards are:

* sourcing raw materials from suppliers who process under an approved QA/HACCP system
* statistically based sampling and testing of raw materials at receival
* ensuring plant specifications for buildings design and operations are up-to-date
* confirming letters of guarantee for ingredients and product supplies are current
* conducting regular random inspections of incoming product and materials
* using magnets and metal detectors where possible to detect metal contamination
* where possible, using stone traps and bone separators
* maintaining all equipment according to manufacturer’s requirements
* training and encouraging operators to identify and correct potential hazards.

Typical methods for reducing biological hazards are:

* sourcing raw materials from suppliers who process under an approved QA/HACCP system
* statistically based sampling and testing of raw materials at receival
* developing and auditing supplier specifications
* developing cold chain management systems
* developing and implementing hygiene and sanitation, GMP’s and prerequisite programs.

Preventative measures are normally recorded on a hazard analysis working sheet.

**Principle 2 – Identify Critical Control Points (CCPs)**

A Critical Control Point (CCP) is defined in *Codex Alimentarius Alinorm 97/13A, Appendix II* as:

*‘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.’*

All significant hazards identified during the hazard analysis must be addressed.

A control point is a point in the process where loss of control is not likely to result in an unacceptable health and safety risk, but preventive measures and problem correction is still required

There is a tendency to err on the side of caution by designating too many points as CCPs rather than identifying the real CCPs.  This may result in a loss of commitment to the real hazard points. On the other hand too few CCPs could be even more disastrous and could cause the sale of unsafe food.

The information gained during the hazard analysis should enable the team to identify, which steps in their process are CCPs and what preventive measures are best suited to control the associated hazard(s).

Regulatory requirements must also be addressed here. For example, the Department of Agriculture requires a Critical Control Point for the control of Zero Tolerance (ingesta, faeces and milk) contaminants in the slaughter floor and offal room process on US registered plants.

CCPs can vary even in the processing of the same meat product. This is normally because of differences in plant layout, equipment used, selection and sources of raw material or the processes used.

The CCP decision tree provides a method for determining if an identified significant hazard requires a Critical Control Point.

But it should be well understood that strict adherence to the decision tree can often lead to the development of a meaningless and unmanageable HACCP system. So it should be used with care – it is a guide only and it’s better to sue the combined knowledge of the team.

The difficulties involved in using the decision tree have also been highlighted in Codex Alimentarius Alinorm 97/13A, Appendix II, where it is stated, in part:

*‘…while the tree has been useful to explain the logic & depth of understanding needed to determine CCP’s, it is not specific to all food operations, e.g. slaughter, and therefore it should be used in conjunction with professional judgement, and modified in some cases.’*



**Example of a CCP decision tree**

Once a critical control point has been identified, it is normally recorded on a hazard analysis working sheet.

Control points not determined as critical but still requiring control should be cross referenced to the appropriate control mechanism, e.g. work instruction (WI) or standard operating procedures (SOP).

In practice only intervention steps such as initial refrigeration and decontamination procedures should be treated as critical control points, since they can be validated.

Most other steps in the processing of raw meat cannot be validated so should not be declared CCPs.

For export-registered establishments listed to export to the USA, the market has mandated a CCP on the slaughter floor and offal room to control zero tolerance defects which are ingesta, faeces, milk or urine. This is usually the final trim on the slaughter floor prior to the carcase wash and at hygiene trim or packing in the offal room.

**Principle 3 – establish critical limits for preventive measures**

A critical limit is defined as the criterion that must be met to assure that the preventive measure(s) associated with each CCP is under control.

Critical limits consist of two types:

* absolute criterion: a physical attribute which gives an indirect indication of food safety; for example, cooking at 70°C for 1 min (if the criterion met, they should result in at least a 7 log10 cycle reduction of a certain bacteria); or
* performance criterion: for example a 2 log10 cycle reduction of aerobic bacteria is achieved by following a sanitising procedure for raw salad.  The sanitising procedure performs to the desired level of pathogen reduction.

However, it is often hard to set critical limits for CCP’s using performance criteria due to the time it takes to get monitoring data back.

Critical limits are often set using information available from sources such as regulations, guidelines, scientific documents, codes of practice, surveys, and experimental studies or from experts in the industry.

Most food companies do not have the expertise or funds to conduct a risk assessment to validate all critical limits less stringent than those commonly accepted by the industry. It may be in the company’s interest to set critical limits more stringent than the regulatory authority to ensure that regulatory requirements are met even when deviations occur.

If critical limits are set more stringent than the regulatory limits then the company must meet those more stringent documented limits.  The product should be safe according to the scope as long as all the CCPs are managed within their specified limits.

In some cases there may be target limits that are more stringent than critical limits.

These are acted upon if a statistical trend occurs in the direction of the critical limit or other information indicates a potential problem arising.

A critical limit separates acceptability from unacceptability. This in effect means that any breach of a critical limit renders the product unfit for human consumption in that form.

This is an issue that needs to be carefully considered when establishing both CCP’s and critical limits. For example if the time and temperature limits in a cooking process are breached, then a decision can be made to prolong the cooking process to ensure product safety. But in the case of the slaughtering and boning process however, such corrective action is not generally available.

If, for instance, a carcase fails to reach less than 7°C in 24 hours from the time of stunning and this is a critical limit (as set by regulation), then:

* what action can be taken to make product safe? (Work in conjunction with the on-plant veterinary when deciding on action)
* should the product be removed from the human food chain?
* how are the items identified?
* does the process have a step that can correct the problem?

Examples of critical limits include:

* time
* temperature
* time/ temperature combination
* humidity
* water activity
* acidity (pH)
* salt concentration
* chlorine level.

In certain products, more than one critical limit may be required to control a particular hazard, e.g. time and temperature requirements for a cooking process.

Critical limits should be measurable and capable of validation (see Principle six). If you cannot measure a critical limit or validate it, it is not a critical limit and the point is not a critical control point to rely on.

Further information on validation of control critical limits can be found in “Proposed Draft Guidelines for the Validation of Food Hygiene Control Measures, 2004, Codex Committee on Food Hygiene”. Information includes methods of validation; steps involved in validation; priorities for validation; and limitations in validation studies.

Since most steps in the processing of animals and meat are not capable of being validated they cannot be critical control points.

For example skin removal is generally recognised as a high-risk procedure, but it is **not** a Critical Control Point because you cannot set measurable critical limits for the operation and so the critical limits cannot be validated. Using the decision tree, you will need to depend on a later operation or intervention to control the hazard.

The main steps in meat processing that can be measured and validated include:

* initial chilling (refrigeration index)

and any intervention steps such as:

* decontamination
* fermentation
* cooking
* refrigeration.

The first step in setting critical limits is to determine if there is a regulatory limit for the hazard.

Regulatory limits should be seen as **minimum** requirements and in many circumstances may not meet the needs of the processing company or other stakeholders.

The adoption of regulatory limits as critical limits may also indicate a lack of rigour in the development phase. For these reasons it is important that the multi-disciplinary team use their knowledge and experience to establish meaningful critical limits that, if complied with, will provide product that consistently meets food safety objectives.

To establish and validate critical limits the following sources of information may be useful.

|  |  |
| --- | --- |
| **General source** | **Examples** |
| Surveys & scientific literature | literature searches  computer databases  internet  predictive models |
| Government agencies & scientific committees | DAFF  FSANZ |
| Experts | CSIRO  Food Science Australia  consultants  equipment manufacturers  university and government agencies |
| Experimental studies | challenge and inoculation studies |
| Company information | records of past practice  microbiological predictive modelling  data trace/log records  microbiological analysis of trial outcomes |

*Adapted from L. Moberg, in Pierson & Corlett, HACCP Principles and Application 1992.*

The main critical limit used in the meat industry is the regulatory requirement that the surface of meat be reduced to 7°C within 24 hours of stunning *(*AS4696:2023 *Australian Standard for the hygienic production and transportation of meat and meat products for human consumption*).

The regulatory requirement of 7°C within 24 hours of stunning can be validated and verified by the refrigeration index.

**What is the Refrigeration Index (RI)?**

The Refrigeration Index is based on extensive research data and is basically is a predictive microbiology tool that has been issued as a computer program that can be used to validate individual chilling systems at abattoirs to prove that the chilling CCP is being met.

The Refrigeration Index (RI) by definition in the Export Control (Meat and Meat Products ) Orders is “A set of criteria used to assess, using an approved microbiological predictive model, the potential growth of *E. coli* at a site of microbiological concern”.

It is basically a measure of the likely growth of a specific indicator organism (*E. Coli*) during processing at temperature above 7°C. Once that temperature is reached the product is considered relatively safe, as *Salmonella* and *E. coli*, which are the main organisms of concern, do not grow.

An increase of 1.5 log of *E. coli* during initial chilling from the hot carcase to 7°C surface temperature in 24 hours is an indicator of acceptable refrigeration. This figure has been built into the RI.

The average RI should not be above 1.5 log for chilled product, in addition 80 % of values must be less than 2 log and no values may be over 2.5.

Note: *E. coli* are used as an indicator organism. Control of *E. coli* also ensures control of Salmonella.

The important thing about this concept is that it measures the process of cooling not just the end-point.

For example a slow initial chill followed by a fast chill can result in a surface temperature of 7°C in 24 hours and apparently meet the standard. But the control of pathogens will not be as good as if the earlier chilling was more effective, as there will be growth of *E. coli* above acceptable levels due to the prolonged higher temperature during the earlier parts of the refrigeration process.

An important aspect of this concept is that it allows variations in processing without compromising the food safety of the product.

The RI is in practice a validation /verification that the mandated food safety objective of 7°C surface temperature in 24 hours is being met.

Most abattoirs use the chilling requirement of 7°C within 24 hours of stunning from the AS4696:2023 *Australian Standard for the hygienic production and transportation of meat and meat products for human consumption* as their main critical control point.

**What is the next step in hazard analysis?**

When you have developed your critical limits, it is time to transfer some the information you have gathered onto the HACCP plan.

The information you have should now include:

* process step
* type of hazard
* preventative measures
* critical control points
* critical limits.

Note: in this example the critical limit is the regulatory limit from the AS4696:2023 *Australian Standard for the hygienic production and transportation of meat and meat products for human consumption*.

It is also a true critical limit as it can be validated by the refrigeration index.

**Principle 4 – establish CCP monitoring**

Monitoring is the measurement or observation at a CCP to assess whether the process is operating within the critical limits i.e. under control.

It is one of the most important parts of the HACCP system, ensuring that the product is manufactured safely at all times. It is essential that the chosen monitoring procedure must be able to detect loss of control at the CCP (i.e. where the CCP has deviated from its critical limit) as it is on the basis of monitoring results that decisions are made and corrective action taken to regain control of the process.

There are two basic monitoring systems:

* on-line system where the critical factors are measured during the process
* off-line system where samples are taken from each measurement of the critical factors.

By far the best system is on-line continuous monitoring which can detect any drift in the process and thus result in a correction to the process to prevent the CCP from going out of control. An example is a continuous recording of temperature data on a canning retort.

When continuous monitoring is not feasible then the frequency of sampling must be sufficient to ensure that the CCP is under control.

Continuous monitoring is not possible in most raw meat processing operations.

Statistically designed sampling plans need to be developed for these instances. The sampling plans would include the frequency of monitoring and the number of samples or recordings necessary to give a high confidence that the hazards are detected.

Five main types of monitoring are usually normally employed, namely:

* visual observation
* physical measurements
* sensory evaluation
* chemical testing
* microbiological examination.

Adequate monitoring is essential in a HACCP system. Monitoring needs to be a planned process that assesses whether a CCP is under control and also to assess if other control points are under control.

Monitoring serves three essential purposes.

Monitoring test results will indicate if the process is trending out of specification. It will allow you to take the necessary action to correct the problem before the critical limit is exceeded.

Monitoring will also determine when there has been a loss of control and the need for subsequent corrective action.

Monitoring records provide the basis for both internal and external verification activities. e.g. record review, audit etc.

Monitoring can be done with automatic devices such as temperature and time charts or by manual systems, e.g. visual inspections and sampling and testing.

**Whichever system of monitoring is used, you must establish a schedule of monitoring that ensures that the CCP is always under control.**

An effective monitoring system will require you to:

* nominate the people responsible for the monitoring
* ensure they understand the purpose and importance of monitoring.

This can be done through a training program, which would include:

* the critical limits
* how test results are recorded
* what to do if critical limits are exceeded.

Developing monitoring procedures for your HACCP plan may require specialist advice.

Generally they can be developed by doing the following:

* identifying the type of monitoring to be done, e.g. temperature check
* deciding the type of monitoring, e.g. random, scheduled or continuous
* determining how often monitoring should occur if it is not continuous
* deciding on the record keeping required for each monitoring task.

Once the team has decided on the appropriate monitoring program the relevant information should be entered into the HACCP plan.

**Principle 5 – establish corrective actions**

Corrective actions are simply what must be done when there is a deviation from a critical limit. A deviation occurs when a critical limit is not met. Corrective actions are decided in advance.

HACCP is designed to correct problems before they affect the safety of food. Therefore, when the system fails and a deviation occurs, there must be procedures in place that will explain the necessary corrective action to take.

Corrective actions are taken when monitoring indicates that there is a deviation from an established critical limit at a CCP.

Since the main reason for implementing HACCP is to establish strategies to prevent hazards from occurring in the first place, then it is important that corrective actions be built in which will correct the process then feedback to build in more robust preventive measures. There are two main types of corrective action:

* corrective actions which adjust the process to maintain control and prevent a deviation from happening in the first place via the use of target or alert limits, and
* corrective actions to be taken following a deviation at a CCP.

The first corrective action normally involves target limits that are more stringent than the critical limits.

When the process **drifts towards or exceeds the target limits it is adjusted to bring it back to normal** – a corrective action that prevents loss of control. This is usually done via a statistical process control (SPC) monitoring system, often using a computer program or charts.

Responsibilities for corrective actions must be spelt out together with record keeping procedures as detailed in Principle 7. Corrective actions should include:

* immediately adjusting the process and ensuring no more defective product will be produced
* quarantining the product for further evaluation/rework/disposal
* checking that action taken to regain control of the process has been effective
* investigating the cause of the incident and taking appropriate action to prevent it happening again
* documenting all action.

**The HACCP plan should describe the corrective action for each CCP and detail the recording action required. In practice, due to space constraints, the corrective action column of the HACCP plan may only contain a reference to a Corrective Action procedure.  
 Principle 6 – Establish procedures for verification**

The AS4696:2023 *Australian Standard for the hygienic production and transportation of meat and meat products for human consumption* has the following definitions.

|  |  |
| --- | --- |
| Validate | Means obtain evidence to demonstrate the effectiveness of a system |
| Verify | Means to apply methods, procedures, tests and other evaluations in addition to monitoring to determine whether a requirement is complied with or a matter is met |

The HACCP system must include verification procedures, methods or tests in addition to those used for monitoring to provide assurance that the HACCP plan is being complied with on a day-to-day basis and achieving the desired outcomes.

The verification determines whether the HACCP plan needs modification or revalidation of certain procedures or criteria. This can be done by an audit system using a planned schedule based on the status and importance of the activity by persons independent of those directly responsible for the activity.

Examples of verification activities include:

* micro testing to ensure pathogen levels/targets are met
* review the HACCP plan to ensure it is being correctly followed
* review the accuracy of the HACCP plan e.g. flow diagram, CCPs
* review of process deviations and product dispositions
* determine if the critical limits are adequate to control hazards
* review of corrective actions
* calibration records
* training of persons responsible for monitoring CCPs.

After the HACCP plan has been introduced, it is important that ongoing verification occurs. The purpose of establishing verification procedures is to ensure that the HACCP System is working correctly and therefore prevent food safety hazards.

For meat processing plants, clause 3.6 of the AS4696:2023 *Australian Standard for the hygienic production and transportation of meat and meat products for human consumption* states that:

*‘A system is in place at the premises to verify whether the matters in this standard that apply to the operation are met by the proprietor and that the results of verification are documented.’*

The aim of the testing is to verify CCPs are under control and that the pre-requisite programmes are working.

Verification activities are carried out in addition to monitoring procedures. Monitoring is not verification.

Verification activities in an Approved Arrangement are a part of the management and control of the system.

In addition to the ongoing verification activities there should be a process for reassessing the HACCP plan to confirm it is working correctly. This reassessment should be done annually.

Reassessment of the HACCP plan may also be necessary after any changes to the process that could affect the original hazard analysis, or when potential new hazards have been identified as a result of changes to:

* processes
* processing equipment or systems
* raw materials or the source of raw materials
* formulations
* production volume
* packaging
* product distribution
* customer, regulatory or company needs.

**Principle 7 – Establish documentation and record keeping procedures**

Efficient and accurate documentation and record keeping is essential to the application of a HACCP system.

Records need to be kept in all areas that are critical to product safety, as written evidence that the HACCP plan is in compliance, i.e. verification that the system has been working correctly.

The types of documentation and records that should be retained include:

* the HACCP plan plus all data collected during its creation e.g. process flow diagram, HACCP control chart, hazard analysis information, details of the HACCP team and monitoring procedures
* justification for hazard selection, risk ratings, critical limits, CCP selection, monitoring frequencies
* amendments to the HACCP plan
* CCP monitoring records
* corrective actions and disposition of nonconforming product
* product trace and/or recall records
* calibration records
* validation and verification records
* training records
* audit records, both internal and external
* management review records.

There is no right or wrong way to design records and forms.   However, time spent planning will save you time in the long run.  Some questions, which might help you, are:

* how often do we need to record the information - hourly, daily, weekly, monthly etc.?
* how many copies are required - superior, file, maintenance etc.?
* can one form be used for several purposes?
* does the form need to be authorised by anybody?
* durability and keeping quality - will paper be sufficient or is a plastic coated form required?  where is the form to be used - near water, heat, blood, fat etc.?
* form layout - portrait or landscape style, how much space for each entry, will the form be completed by hand or on a computer etc.?
* does the record/form have to be sequentially numbered?

Your hazard chart can now be completed.

How should the HACCP plan be implemented?

The next step is to implement the HACCP plan. Most experts estimate that development, installation and implementation will take between six months and two years. In order to implement the system properly, the following must occur:

**Ensure that sufficient resources (human, physical and financial) are available**

Note: Physical resources include equipment and facilities

Equipment includes the correct utensils, equipment and construction to prevent or minimise the risk of a hazard occurring. These need to address hygienic design and work ergonomic issues.

Equipment must be designed to prevent contamination of food during processing and be capable of easy cleaning and sanitising after use. Ease of operation of equipment and correct positioning allows for employee usage, for example automated hand wash basins correctly situated at each work station.

Facilities needed include training rooms, computer access, monitoring stands and record keeping facilities.

**Ensure monitoring of CCPs is carried out**

CCP monitors will only perform effectively if they understand what they are expected to do, why they are doing it and how it fits in with the rest of the HACCP system.

**Ensure records are kept; and ensure training is implemented.**

|  |
| --- |
| **Activity suggestion five: HACCP plan requirements**  **Materials and specialist personnel**  QA manager.  Copies of regulatory requirements relating to HACCP based QA systems, e.g. state meat authority requirements, Australian standards, etc.  Copies of establishment HACCP plans.  Product and process flow charts.  Monitoring procedures and records.  Relevant SOPs.  Access to slaughter floor or production area.  PPE.  **Method**  Invite the QA manager to discuss the economic impact on the establishment and the potential impact on public health and safety of company failure to identify and control food safety hazards.  Analyse the regulatory requirements, codes and guidelines for HACCP based QA systems. Examine and explain company documentation and systems in relation to these requirements. Brainstorm internal and external sources of information and assistance for HACCP.  Make sure the trainee is wearing appropriate PPE and tour the floor or production area, following all hygiene requirements. In discussion with trainee, identify and note potential hazards and control points in a process that the trainee knows well.  Back in the training room, examine the CCPs identified by the trainee and discuss the elements relating to them – e.g. process flow charts, type of hazard, critical limits, monitoring procedures, corrective actions, verification, etc.  **Trainee activities**  Ask the trainee to develop or review a HACCP plan for a simple procedure such as boning or meat retail. |

**Perform pre-operational hygiene inspection**

**Why are pre-operational hygiene checks performed?**

Pre-operational hygiene inspections are performed at meat processing plants because it is essential that every surface touched by product should be visually free of food particles, no foreign objects present, no insects or vermin present, be free of chemical residues, and not have excessive microbial populations.

The biggest danger is the formation of a ***biofilm***. A biofilm starts when micro-organisms land on a surface and attach themselves with their filaments. They then release a type of glue that helps attach them even more closely to the surface. If they are not removed the layers will build and other micro-organisms will bury themselves in this glue. This is called a biofilm. It can occur on meat and on operational surfaces and once established acts as a protection against sanitisers to micro-organisms.

Using water that is too hot in the pre-rinse phase cooks protein onto the surface and thus helps promote biofilm growth. Hard water with the incorrect detergent precipitates calcium salts and forms scale on the surface of structures and also creates a medium for biofilm growth.

The use of the correct chemicals and physical scrubbing are the most important means of ensuring biofilms do not develop.

A commercially clean surface will not be sterile, but the number of organisms on a product contact surface should be much less than the number on the product passing over it. The surfaces should not add significant numbers of spoilage organisms to the product passing over it, and the total environment should not have any food-poisoning organisms present.

Therefore, the process of cleaning and sanitation is to ensure that the *'cleaned' work surface does not add organisms to an otherwise satisfactory product*.

Several methods can be used to see if a surface is clean:

* general appearance - contamination or oxidation should not be visible under good lighting conditions. particles of meat should not be present in the cleaned room
* the work surfaces should not feel greasy or rough when rubbed with the fingers
* a clean white tissue should not be discoloured when rubbed over the surface of cleaned stainless steel - this is not applicable to aluminium or galvanised material
* no objectionable odour should be detected
* all surfaces should be dry before work, as a result of cleaning operations the previous night
* when a cleaned surface is wetted, the surface should not show signs of excessive water breaks while water is passing over the surface
* after cleaning and sanitising, the work surfaces should have microbial populations below a maximum value, the value depending on the product, its stage in processing and expected storage life.

The above tests are quickly performed and must be done on a daily basis by a trained quality-control officer as part of the routine preoperational hygiene inspection.

**How should pre-operational hygiene checks be performed?**

It is the responsibility of meatworks management to ensure their premises are clean. It is the responsibility of the Quality Assurance Officer to ensure that a pre-operational hygiene inspection is undertaken of all processing areas.

Meat inspection staff employed by a regulatory authority when they inspect should only need to monitor the work of the company employee conducting the inspection.

Every person who performs a pre-operational hygiene inspection need to be equipped with a good torch, scraping instrument, paper towels, pencil, paper and an ample supply of retain tags. They may also take a camera to photograph observations. A rational approach should be adopted, as only a limited time is available for the inspection and as such:

* emphasis must be placed on equipment and materials that would, or are likely to contact edible product
* where quantities of equipment are involved, for example gambrels, containers, tables etc., it may be necessary to examine only representative samples to assess general cleanliness
* dismantled equipment and chutes should not be assembled prior to inspection
* set patterns and time schedules should be avoided.

Retain tags may be used for attachment to equipment and works areas or rooms. This tag must be correctly filled in, listing the item tagged, the reason for tagging, the inspecting person's name and the date.

When a tag is placed in a room, or on equipment etc., this indicates that the room, equipment etc. cannot be used until it is satisfactorily cleaned or repaired or treated. Where deficiencies are noted in certain areas, it is not necessary to suspend operations throughout the plant, provided the other operations are not adversely affected. For example an unclean boning room would not delay the kill in any way; however, the boning room could not be used until the faults were corrected.

Since bacteria cannot be seen by the naked eye, visual inspections although giving a good assessment of visual cleanliness does not give any indication of the microbiological status of the surfaces. Therefore, some technique for checking the level of microbial contamination is necessary. This is described in the next section.

**What records should be kept?**

All monitoring activities need to be recorded – conforming as well as nonconforming results. Record keeping activities can take a number of forms, such as monitoring sheets and checklists. The format will generally be workplace specific. An example of a simple pre-operational hygiene monitoring follows:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Sample only*** | | | | | | |
| **Bob’s boning room EST. NO. 999**  Checker: Daily pre-operational hygiene checklist Week ending  \_\_/\_\_/\_\_\_\_ | | | | | | |
| Area Checked Date | Mon \_\_/\_\_ | Tues \_\_/\_\_ | Wed \_\_/\_\_ | Thurs \_\_/\_\_ | Fri \_\_/\_\_ | Sat \_\_/\_\_ |
| **Processing room** |  |  |  |  |  |  |
| Walls/Floors/Lights/Drains |  |  |  |  |  |  |
| Tables/Cutting boards |  |  |  |  |  |  |
| Edible bins/Trays/Tubs |  |  |  |  |  |  |
| Mincer/Sausage filler |  |  |  |  |  |  |
| Brine pump/Vacuum sealer |  |  |  |  |  |  |
| Band saw/Slicer |  |  |  |  |  |  |
| Personal hygiene |  |  |  |  |  |  |
| Knives/Pouches/Aprons |  |  |  |  |  |  |
| Wash basin/Soap Dispenser |  |  |  |  |  |  |
| Handsaws/Choppers |  |  |  |  |  |  |
| Paper towel dispenser |  |  |  |  |  |  |
| Waste bins/Inedible tubs |  |  |  |  |  |  |
| Chillers/Freezers |  |  |  |  |  |  |
| Walls/Ceilings/Floors |  |  |  |  |  |  |
| Racks/Rails/Supports |  |  |  |  |  |  |
| Amenities |  |  |  |  |  |  |
| Lunch room |  |  |  |  |  |  |
| Locker room/Toilets |  |  |  |  |  |  |
| Ancillary Area |  |  |  |  |  |  |
| Loadout area |  |  |  |  |  |  |
| Carton storage |  |  |  |  |  |  |
| Ingredients storage |  |  |  |  |  |  |
| Chemical store |  |  |  |  |  |  |
| Waste collection area |  |  |  |  |  |  |
| **Date/Day** | **Defect** | **Corrective actions** | **Sign** |
|  |  |  |  |

Everyone undertaking a pre-operational hygiene inspection whether that person is employed by the company or by the controlling authority should prepare written reports.

These reports are indicators of consistent performance and should be made available for audits.

**What corrective actions should be taken on adverse findings?**

Corrective action must be taken on all adverse findings on preoperational reports.There are four aspects to corrective action:

* correct – bring nonconforming activity back into control
* isolate – where practicable identify, isolate and deal with non-conforming product or area
* determine cause and correct – determine the causes, then fix the problem to prevent recurrence of the nonconformity
* document – record the non-conformance identified during monitoring and the corrective action(s) taken.

The following criteria should be used when assessing the seriousness of a non-conformity and the urgency of corrective action.

|  |  |  |
| --- | --- | --- |
| **Classification** | **Impact on food safety** | **Definition** |
| Critical | Certain to affect food safety | Certain: Inevitable or seems inevitable |
| Major | Likely to affect food safety | Likely: Reasonable to assume, but not certain |
| Minor | Potential to affect food safety | Potential: Low probability |

As a general rule only hygiene faults that would directly affect the product being processed require immediate correction. Problems that are developing or that do not cause immediate hazard to product can be corrected at a later time.

But if in the assessment of the inspecting person the overall cleanliness of the premises is not adequate, then the whole premises should be re-cleaned. Hygiene faults can be assessed as falling into the four risk categories set out below:

***Direct product contamination*** - Hand tools, knives, saws, cutting boards, table tops, inside surfaces of trucks, choppers, grinders and any appliance handled by workers who will be involved in handling of product; all problems in this category require immediate and effective correction.

***Possible product contamination*** - Doorways, posts, smoke trees, workers' clothing, outside surfaces of buckets, rail switches. These items must meet the same standard of cleanliness as for items listed above, but deficiencies in some cases can be corrected while operations are in progress.

***Potential product contamination*** - Floors, certain walls, rails and underside of trucks, tables and platforms. These surfaces come in contact with product by accident. Some of these may require cleaning immediately, while others may require cleaning before the next day's operations begin.

***Remote product contamination*** - Walls behind large pieces of equipment, stairwells, windows. These areas are unlikely to cause a direct hazard to product, but still have to be cleaned. These areas can be corrected within an established hygiene program.

All the above categories can be changed according to the extent of the contamination. A thorough pre-operational hygiene inspection is an important part of the total process of ensuring that meat fit for human consumption is produced.

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| **Activity suggestion six: Pre-operational inspection**  **Materials and specialist personnel**  QA manager.  Copies of preoperational inspection work instruction and pre-operational inspection checklist  Relevant SOP.  Access to slaughter floor or production area.  PPE.  **Method**  Invite the QA manager to discuss how pre-operational inspection is performed.  **Trainee activities**  Ask the trainee to perform a preoperational hygiene inspection of an area using the workplace form and report findings to the responsible person. |

**Perform microbiological testing**

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| --- | --- |
| **WI** | **What are the requirements for microbiological testing in the meat industry?** |

The *Australian Standard* requirements for micro-biological testing are set out in *Micro-biological Testing for Process Monitoring in the Meat Industry*.

Under the principles of HACCP, verification of the process is required. Microbiological testing of products and working surfaces are a part of the verification process.

To verify the HACCP program the following needs to be carried out:

* regular micro-biological testing of product must be carried out to verify the HACCP programs at your workplace
* regular micro-biological testing of meat contact surfaces must be carried out to verify the cleaning programs at your workplace
* a schedule of testing must be included in your HACCP plan. This means you must monitor your CCPs through micro-biological testing, to show that your HACCP programs are effective and working
* test results must be analysed to see if you are meeting the required critical limits
* if critical limits are not being met, you will have to make changes to your HACCP program. This is to make sure that the critical limits are sufficient to control the hazards identified and analysed in your HACCP program.

Recent surveys have been carried out on the micro-biological quality of Australian meat. Based on these surveys, guidelines for what is acceptable have been developed.

Records must be kept so that you can set benchmarks you can aim for, and trends can be identified. Testing needs to be consistent to make this possible.

***Testing***

Sampling and testing should be carried out following the guidelines in *Micro-biological Testing for Process Monitoring in the Meat Industry*.

***Export***

Depending on the importing country, export requirements for micro-biological testing will differ from domestic requirements. The main program is the *E.coli* and *Salmonella* Monitoring (ESAM) program.

This is the *E.coli* and *Salmonella* testing program. It is equivalent to the micro-biological testing conducted under the *Australian Standard*.

In fact, it is more extensive, better targeted and more frequent than that required for domestic meat. It was introduced in response to US demands for a testing program equivalent to their ‘*Pathogen reduction program*’. ESAM varies little from the US program.

In all cases, workplace instructions must be followed when carrying out micro-biological testing.

|  |  |
| --- | --- |
| **WI** | **What are your company work instructions for surface microbiological testing?** |

Read the company work instructions for the microbiological sampling of work surfaces. You will note that:

* samples are to be collected on a regular basis
* a range of product contact surfaces and equipment has to be sampled
* the method of sampling is strictly defined, even the surface area to be sampled is strictly defined
* the method of culturing the samples are strictly defined
* there will be a set of guidelines or regulatory requirements that spell out specifically what is required and how it is to be done.

The microbiological assessments can help verify that the methods of cleaning are effective and are an essential part of any HACCP based food safety program.

Standard plate counts are usually conducted for this purpose. The Standard *AS 5013.1:2004 Food microbiology-examination for specific organisms - standard plate count* should be used as the guide.

The methods used for microbiological testing of surfaces in meat plants fall into three general categories: contact methods, swab methods, and rinse methods.

**How are meat samples collected for microbial examination?**

For results to be meaningful, representative samples must be properly collected, prepared and dispatched. Where possible, samples should be collected as a discrete unit, i.e. a whole chicken, a can of ham, etc. In other instances, samples will need to be taken from a larger unit, for example, a carcase, a carton of meat, etc.

***Overview of steps and issues***

Before starting a sampling task, check your procedure for:

* the necessary equipment
* all safety information
* essential sample preservation details
* container specifications
* location of sampling points
* sample storage needs
* correct labelling and sample codes.

During a sampling task:

* make sure each sample goes into the matching labelled container
* ewnsure that you and your actions do not become a source of sample contamination
* follow the method rigorously, e.g. rinse then fill, or access the sub-surface, or exclude an airspace
* adhere to all specified sampling details, such as flushing times and sample sizes
* exercise special care with unstable, delicate or sensitive samples.

After the samples are obtained:

* store correctly, e.g. temperature, sunlight exposure or agitation may need to be considered
* inspect to see if the preservative has not obviously failed
* complete labelling and coding and other records
* dispatch to destination with covering documents, to indicate what it is and what needs to be done
* comply with time constraints
* dispose of waste material and surplus or defective samples, according to the established guidelines and systems.

***Aseptic sampling***

If external packaging needs to be breached during sampling collection, great care is required to prevent contamination of samples from outside sources.

Keeping the samples free from the living germs or disease, fermentation or putrefaction is **aseptic sampling**.

It is particularly important for microbiological sampling.

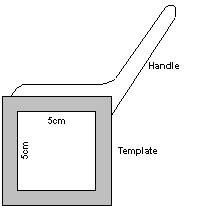
Principles of aseptic sampling are:

* conduct sampling in clean surroundings – find an area free from potential contaminants, e.g. dust, exhaust fumes and choose a work surface that can be covered and/or sterilised with alcohol
* keep yourself clean – wear clean hat and coat, wash hands with soap and warm water and put on latex or plastic gloves after washing hands
* – plan your sequence of sampling, e.g. collect packages for sampling before setting up for sampling
* have a range of sterile containers and sampling equipment available – this may include sterile bags, templates, forceps, tongs, knives, scissors etc. and a means of sterilising equipment should accidental contamination occur
* work quickly – when package to be sampled is open, sample must be drawn quickly so as to minimise the potential for contamination.

**What equipment is used to collect samples for microbial analysis?**

When taking swabs from carcases, for microbiological assessment, the following equipment may be used:

* template – a template is a piece of wire or plate which is the exact dimension of the area which has to be swabbed, e.g. beef/pigs – 10 cm x 10 cm, sheep/goat/lambs/calves/deer – 5 cm x 5 cm.



**Sampling template**

* sterile gloves – used to prevent cross-contamination from sampler to carcase surface, sampling sponge, template, sample bag etc.
* sanitising agent – used to sanitise sampling equipment between carcases or whenever contaminated, e.g. you may use 82°C water, sodium hypochlorite solution or alcohol
* propane burner – used to sterilise the water outlet or tap mouth in water sampling



**Propane burner**

*© MINTRAC*

* sterile specimen sponge in sterile Whirl-pack™ bag or equivalent – used to swab carcase surfaces for *E.coli* and *Salmonella*



**Sterile Whirl-pack™ bag**

*Courtesy Fletcher International*

*© MINTRAC*

* sterile Butterfield’s phosphate dilutant (BPD) – used to moisten sponge used for E.coli and Salmonella testing



**Sterile Butterfield's phosphate dilutant bottle**

*Courtesy Fletcher International*

*© MINTRAC*

* sterile zip lock-type or stomacher bag – packing used to enclose sponge bag for dispatch to analytical laboratory.

**How are micro-organisms identified?**

To positively identify a specific micro-organism that may be contaminating food is a very long task. The microbiologist undertakes a series of standard, complex steps, procedures, tests and analysis.

* A sample of ‘suspect’ food or a swab is taken. This is done in a way that ensures that it does not become contaminated with any other source of micro-organism which would ruin the rest.
* This sample is then taken to a microbiological laboratory for a full analysis. Simply placing a piece of the suspect food under the microscope will not allow us to effectively study the micro-organism. This is because the micro-organism would not show up very clearly with all the particles of food obscuring the view of the microscope.
* The micro-organism must first be separated or ‘isolated’ from the food. A very small amount of the food containing the contaminating micro-organism is placed onto a small dish, which has a material specially formulated to contain all the things the micro-organism needs to grow. The dish is called a petri dish and the specially formulated material is usually in the form of a gel and is referred to as nutrient agar. The type of agar would vary depending upon the type of micro-organism the microbiologist is trying to grow. This procedure is referred to as inoculating the agar plate.
* Next, the inoculated petri dish is placed in a cabinet at a specific (nice and warm) temperature which encourages extremely rapid growth of micro-organisms.
* Now, if everything has gone according to plan, after a set time (usually a few days), the petri dishes will be removed from the incubators and there will be visible growths of the micro-organism on the agar. These growths are referred to as colonies. These colonies are, in fact, billions of the individual micro-organism that were reproduced by the micro-organism that contaminated the food originally.
* Now that they have been isolated, they are in the form of what is generally referred to as a pure culture of a specific micro-organism.
* The micro-organism, now in its ‘pure’ form, that is, a large number of identical micro-organism, can be studied using the microscope and other procedures to assist in positive identification.
* The microscopic observations will allow the microbiologist to determine the micro-organism characteristics, referred to as the morphological characteristics.

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| **Activity suggestion seven: Microbiological swabbing**  **Materials and specialist personnel**  QA manager.  Copy of relevant work instructions  Relevant SOP.  Access to slaughter floor or production area.  PPE.  **Method**  Invite the QA manager to discuss how both surface and carcase microbial swabbing is performed  **Trainee activities**  Ask the trainee to perform microbial swabbing of product contact surfaces and / or of a carcase. |

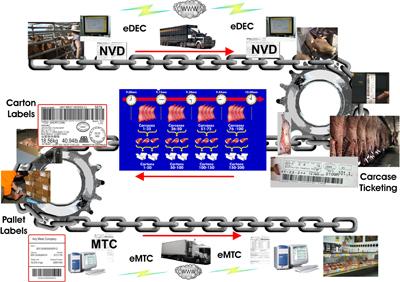
**Electronic systems in the meat industry**

The red meat supply chain has adopted the GS1[[2]](#footnote-2) standards for Numbering, Bar coding and Electronic messaging for specific red meat supply chain activities such as:

* carton labelling
* carcase ticketing
* pallet labelling
* electronic messaging for National Vendor Declarations (eDEC)
* Electronic Meat Transfer Certificates (eMTC).

Many meat processing plants have commenced introducing these electronic systems. Meat processing supervisors need not only be aware of the nature and general requirements of these systems, but also be able to identify and rectify errors and to take responsibility for the smooth operation of the system at the plant.

The diagram below shows the red meat supply chain and identifies each of the activities, what the relationship is of each of the activities and their respective importance along the supply chain.



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The implementation is being coordinated by the Red Meat Supply Chain Committee. To date the committee has produced the Australian Red Meat Numbering and Bar coding guidelines for non-retail meat products, Message Implementation Guidelines, technical fact sheets, case studies, interactive CDs and a cost benefit analysis relating to project outcomes.

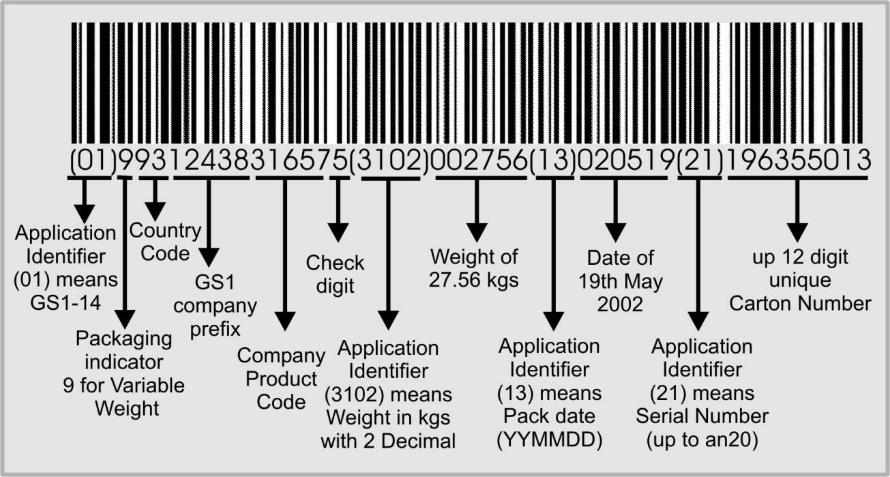
**What is a Variable Weight Carton Label?**

The Australian red meat industry Standard Variable Weight Carton Label uses Bar code symbology known as GS1-128. The GS1-128 bar code allows primary item information and secondary attribute information to be represented in the bar code. Application Identifiers (AIs) effectively act as prefixes for this information and define the meaning and structure of the embedded data.

GS1 Australia allocates a parcel of numbers to member companies. These numbers include a GS1 Company Prefix to identify the company and a range of numbers to identify products (which members themselves allocate sequentially), followed by a Check Digit which is mathematically calculated to verify that the details of the GS1 number (GTIN) are correct.

The system also allows the meat processor to represent attribute information such as batch numbers, serial numbers, expiry dates and weight in a standard format. This ensures that the attribute information encoded by one company can also be scanned and interpreted by any other company in the supply chain.

Below is an explanation of the construction of the bar code.



*© Meat and Livestock Australia*

**What are a supervisor’s responsibilities in relation to Variable Weight Carton Labels?**

The supervisor has a responsibility to ensure:

* that the minimum bar code information required (represented by Application Identifiers (AIs)) is accurate and is formatted correctly
* that the maximum length, magnification and height of bars of the bar codes conforms to the requirements described in the Technical Fact Sheet[[3]](#footnote-3)
* that the Application Identifiers (AIs) are clearly recognisable by placing them in brackets in the human readable interpretation
* that the bar code symbols are placed according to the specifications in the Technical Fact Sheet.

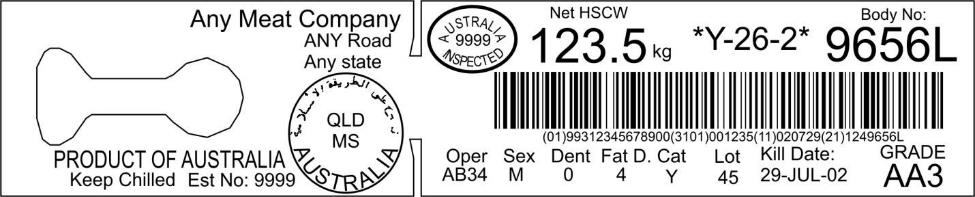
**What are Variable Weight Carcase labels?**

Australian red meat industry standard Variable Weight Carcass Labels use bar code symbology known as GS1-128.

The GS1-128 Bar Code Symbol allows primary item identification and secondary attribute information to be represented in the bar code. Application Identifiers (AIs) effectively act as prefixes for this information and define the meaning and structure of the embedded data which follows.

The system also allows a processor to represent attribute information such as weight, slaughter date and serial numbers in a standard format. This ensures that the attribute information encoded by one company can also be scanned and interpreted by any other company in the supply chain.

An example of a carcase label appears below.

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*© Meat and Livestock Australia*

**What are a supervisor’s responsibilities in relation to Variable Weight Carcase Labels?**

The supervisor has a responsibility to ensure:

* that the minimum bar code information required (represented by Application Identifiers (AIs)) is accurate and is formatted correctly
* that the maximum length, magnification and height of bars of the bar codes conforms to the requirements described in the Technical Fact Sheet[[4]](#footnote-4)
* that the Application Identifiers (AIs) are clearly recognisable by placing them in brackets in the human readable interpretation.

**What are GS1 Logistics (pallets) Labels?**

The GS1 Logistics label provides information about the unit to which it is fixed. The GS1 Logistics Label can be applied to a single item, or a grouping of several items made up to facilitate the operation of handling, storing and shipping. This can be a carton, a pallet, a container or any other similar type of packaging created for the purpose of handling, storing or shipping.

This information on the Logistics Label is supported and complimented by Application Identifiers (AIs) and the GS1-128 Symbology. These are important components of the Logistics Label and apply to all of the specifications relating to the logistics label.

The core information on the label should be represented both in bar code and human readable form. There may be other information, which is represented in human readable form only.

Some trading partners may request additional information in a separate bar code above the SSCC. Major supermarket chains may have specific pallet label requirements that are additional to the basic requirements for pallet labels. Check for any specific pallet label requirements and ensure that they are included in the company work instructions and quality assurance programs.

The SSCC is a unique, non-significant, eighteen-digit number, which is assigned by the company constructing the logistic unit. It remains the same for the life of the logistic unit.

Below is an example of a pallet label.



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**What are a supervisor’s responsibilities in relation to GS1 Logistics (pallets) Labels?**

The supervisor must ensure that:

* the allocated SSCC ( a unique, non-significant, eighteen-digit number, which is assigned by the company constructing the logistic unit) is encoded in a GS1-128 Bar Code Symbol, and is identified by the Application Identifier (00)
* that an individual SSCC number is not reallocated within one year of the shipment date from the SSCC assignor to a trading partner
* the accuracy and placement of the Application Identifier (AI)
* the accuracy and placement of the Extension Digit
* the accuracy and placement of the GS1 Company Prefix
* the accuracy and placement of the Serial Reference
* the calculation of the Check Digit which ensures the whole number is correct
* that any other labelling information over and above the SSCC complies with the specification of the Technical Fact Sheet[[5]](#footnote-5) and with the proper use of AIs
* that the label layout conforms to the specification in the Technical Fact Sheet
* that the Bar Code Symbol specifications, including magnification, height of bars, human readable information, and label location are correctly applied.

**What is the electronic Messaging for Cattle and Sheep National Vendor Declaration (eDEC) System?**

The eDEC system is a means to communicate using common standards between trading partners:

* producer to producer
* producer to saleyard
* producer to feedlot
* producer/ feedlot/ saleyard to abattoir)

The eDEC system is based on the use of the GS1 system and specifically EANCOM messaging standards.

The livestock declarations (NDV, Waybill, MSA declaration) and commercial consignment information can be represented in the standard EANCOM Despatch Advice message that is used for information related to consignments and commercial information transmission between businesses.

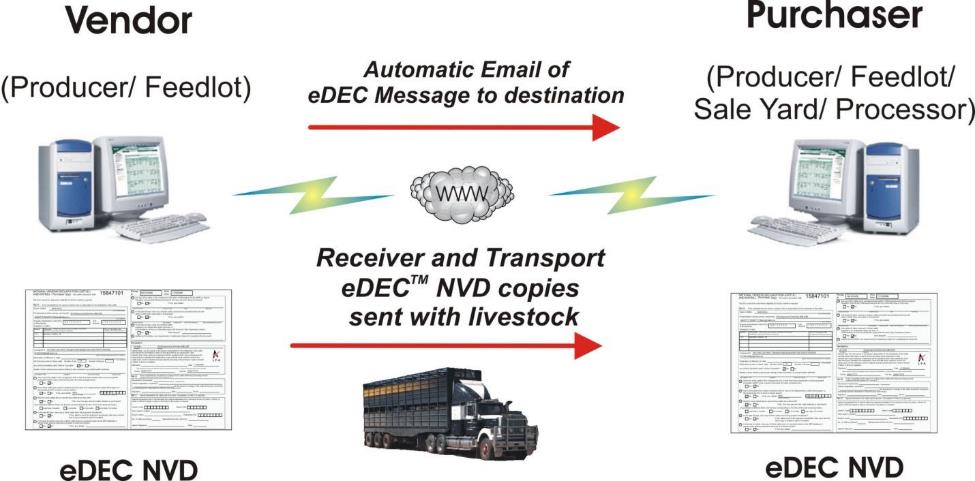
The requirement for efficiently sending industry and company specific commercial information electronically between businesses is also included in the eDEC system.

The electronic Livestock Declaration (NDV, Waybill, MSA declaration and NFAS declarations) eDEC system works by recording the required declaration and commercial information by the consignor (sender). The information is then sent electronically to the consignee. A duplicate declaration docket is generated and is signed by the consignor. The original is sent with the consignment and the duplicate is kept with the consignor.

When the consignee (receiver) receives the physical shipment they check it against the eDEC and if all is correct then generate a receipt message. This message is automatically emailed back to the consignor (sender).

The eDEC system uses the EANCOM Despatch Advice message for the consignment details and the EANCOM Receiving Advice message for the proof of delivery.

Below is a diagrammatic explanation of the eDec system.

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**What are the supervisor’s responsibilities in relation to the eDEC system?**

The supervisor should be familiar with the technical elements of the eDEC system, security issues to be considered, methods to send and receive messages and the regulatory considerations.

The specifications for the eDEC system are described in the Australian Red Meat Industry *Technical Fact Sheet - the electronic Messaging for Cattle and Sheep National Vendor Declaration (eDEC) System*.[[6]](#footnote-6)

In particular, the supervisor’s responsibilities include:

* ensuring the security and application of the company password
* management and storage of original and duplicate documents
* correlating actual numbers received on site with what was provided in the emailed NVD, following up inconsistencies in members and recording discrepancies
* identifying errors or possible issues with the way questions have been answered in the emailed NVD and taking appropriate action according to company procedures (e.g. telephoning the producer to seek additional information)
* checking that all critical pieces of information have been correctly entered (including signatures) and any invalid information is identified and correct information provided
* ensuring that the common information (such as the trading names, address and phone number of a specific property) held in the eDEC message creator tool is accurate
* ensuring that reports printed showing the consignment details are matched to the physical consignment
* checking that the EANCOM Receiving Advice receipt message is created and then sent via email to the required consignor and nominated Department of Agriculture recipient
* addressing and resolving errors identified in the reports
* ensuring that records of matched messages are filed electronically and manually and held for the statutory period
* ensuring that the EANCOM Quality Test Report message is generated, checked and provided to the consignee, according to company procedures.

**What are the Electronic Meat Transfer Certificates (eMTC)?**

The eMTC system is a means to communicate between trading partners using common standards. The eMTC system is based on the use of the GS1 system and specifically GS1 EANCOM messaging standards.

The Electronic Meat Transfer Certificate (eMTC) system is based on industry trials that involved the development of the EANCOM Despatch Advice message for the export of carton product matching the health certificates MLA trial completed in 2003.

The EANCOM Despatch Advice message implementation guidelines for export product were expanded to take into account the specific requirements of Meat Transfer Certificates. This included the requirements for an EANCOM Receiving Advice message for the proof of delivery (Attestation of Receiving Official).

The requirement for efficiently sending commercial information electronically between businesses was also considered and included in the eMTC system.

The Electronic Meat Transfer Certificate (eMTC) system works by recording the required MTC information by the consignor (sender). The information is then sent electronically to both the consignee (receiver), Department of Agriculture central recording systems and where relevant to the nominated Department of Agriculture on-plant email address.

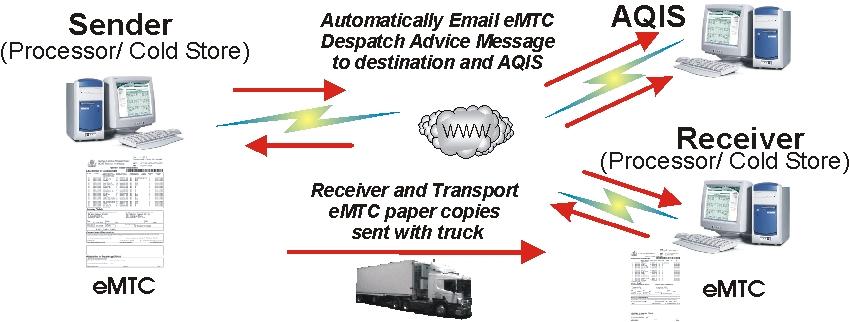
A ‘look-a-like’ MTC form can be printed to accompany the consignment and/or for record keeping.

When the consignee (receiver) receives the physical shipment the consignee checks it against the eMTC and if all is correct generates a receipt message.

This message is automatically emailed back to the consignor (sender) and the DAFF officer.

The eMTC system uses the EANCOM Despatch Advice message for the consignment details and the EANCOM Receiving Advice message for the proof of delivery.

Below is a diagrammatic explanation of the eMTC process.



*© Meat and Livestock Australia*

**What are the supervisor’s responsibilities in relation to the eMTC?**

The supervisor has a responsibility to ensure that the technical elements of the eMTC system are observed, security issues are managed, methods to send and receive messages and the regulatory (Meat Export Orders, acts and codes of conduct) are observed.

These requirements are described in detail in the Australian Red Meat Industry *Technical Fact Sheet - the electronic Meat Transfer Certificate (eMTC*)[[7]](#footnote-7)

In particular, these responsibilities include ensuring:

* the security and application of the company password
* that emailed GS1 EANCOM messages for each consignment are matched to the physical consignment
* that any errors identified between the GS1 EANCOM message and the physical consignment details are identified, reports are created showing the errors and action taken on the identified errors
* that the nominated DAFF recipient of the eMTC messages about consignments receives the messages
* that Message Details conform to the EANCOM Despatch Advice Message Implementation Guidelines and the EANCOM Receiving Advice Message Implementation Guidelines
* that System Vendor solutions print a paper MTC in the format that is approved DAFF and which conform, to the specifications described in the *Technical Fact Sheet - the electronic Meat Transfer Certificate (eMTC*)
* that all printed documents conform to the specifications described in the *Technical Fact Sheet - the electronic Meat Transfer Certificate (eMTC*), and are stored appropriately.

**TACCP and VACCP**

**What is TACCP and VACCP?**

TACCP and VACCP together provide a methodical system for assessing threats and identifying vulnerabilities in the food supply chain. They are used to:

* minimise the likelihood and impact of deliberate attacks
* implement controls to mitigate risks.

**VACCP** stands for ‘Vulnerability Assessment Critical Control Points’. VACCP is used to identify and prevent vulnerabilities in a food chain where food fraud may occur.

Food fraud is when food is put on the market with the intention to deliberately deceive the customer for financial gain. It includes counterfeiting, adulteration, smuggling, stolen goods, dilution and mislabelling.

**TACCP** stands for ‘Threat Assessment Critical Control Points’. TACCP is similar to VACCP but is used to identify the threat of behaviourally or ideologically motivated adulteration of food. Threats could include intentional contamination of food products, sabotage of the food chain, and using food or drink items for terrorism or criminal purposes.

Intentionally tampering with food is often malicious and motivated by wanting to cause harm, either to people or a business. TACCP focuses on defence and analysing the factors that might influence someone to commit such a crime

TACCP and VACCP are part of the Food Management Safety System and aligned with HACCP practices.



**What are the types of threats and vulnerabilities?**

***Economically motivated***

Economically Motivated Adulteration (EMA) are threats motivated by financial gains. This is where non-authentic substances are added to food or authentic substances are removed or replaced in food for financial gain.

The two main types of EMA are:

* selling food which is unfit for consumption and potentially harmful. For example, recycling animal by-products back into the food chain, packing and selling meat of unknown origin or knowingly selling goods past their use-by date
* deliberately mislabelling food. For example, products substituted with a cheaper alternative, false statements about where the ingredients were sourced.

EMA deceives customers by providing them with lower quality food products without them knowing. It can also have serious implications on food safety and customer’s health.

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| **Example**  In 2017 an undercover investigation revealed a large chicken processor in the UK was repackaging products returned from distribution centres as if they were fresh. ‘Kill dates’ for chickens were also being deliberately misrepresented to extend the expiry date of finished products.  The Food Standards Agency investigated and also found fraudulent *Salmonella* testing of carcases.  As a result, major supermarkets suspended purchases from the firm, work at one plant was suspended for two weeks and another plant closed permanently. A plant in Scotland was also closed later that year. The company reported losses of £38 million (approx. $AUS 70 million) for the year. |

***Malicious contamination***

Malicious contamination is where disgruntled individuals, criminals or terrorists intentionally contaminate food to cause harm. Malicious contamination can severely threaten the safety of consumers and the food chain.

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| **Example**  In 2018 a disgruntled Queensland strawberry farm employee was charged with seven counts of contaminating goods after planting sewing needles in the fruit over several months.  The contamination sparked copycat crimes and hoaxes all over Australia and led to supermarkets pulling strawberries of the shelf and tonnes of fruit being dumped at the peak of the growing season.  There were 186 reports of needles being found, 77 of those were in Queensland and 15 were hoaxes. Sixty-eight strawberry brands were affected, and the industry lost an estimated $1 million worth of fruit. |

***Extortion***

Extortion is where food products are intentionally altered without the manufacturer’s knowledge for financial gain.

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| **Example**  In 1989 slivers of glass, razor blades, pins and caustic soda were found in H J Heinz baby food. The extortioner demanded four million pounds from the manufacturer.  Five babies were hospitalised after being fed the contaminated food. A UK policeman was eventually caught after a managing to net just £32,000 (approx. $AUS 60,000). He was convicted and sentenced to 17 years in jail. |

***Counterfeiting***

Counterfeiting is when a food product is substituted or copied without the manufacturer’s knowledge for financial gain.

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| **Example**  In 2011 340 bottles of Jacob’s Creek wine were seized by authorities in the UK. The wine had the winemaker’s label and looked identical to the original except that the label was mis-spelled – it claimed to be a ‘Wine of Austrlia’.  The wine was of very low quality and believed to have come from China. It was being sold in UK off-licences for around £2 ($3.60).  Jacob’s Creek is a popular wine In the UK and usually sells for around £10 ($18) a bottle. |

***Cyber crime***

There are two main types of cybercrime that can affect the food chain – ransomware attacks and fraudulent sales via the internet.

Ransomware is a type of malicious software or malware designed to block access to a computer system. The affected organisation then must pay a ransom to get access to the files or system.

Fraudulent sales over the internet involve the seller pretending to be legitimate online sellers. Once an order is placed and paid for, the seller then sends counterfeit goods or does not deliver any goods. If a credit card is used for payment, they may then use the credit card details to access money from the account.

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| **Example**  In 2017 a global ransomware attack known as Petya, crippled businesses around the world, including the Cadbury factory in Tasmania.  The ransomware took over computers and encrypted important documents and files then demanded a ransom for a digital key to unlock the files. If people affected didn’t have a recent back-up of the files, they had to either pay the ransom or risk losing it all.  Mondelez International, the owner of Cadbury, said that the attack shrunk their second quarter revenue growth in that year by 3%. |

***Espionage***

The primary purpose of espionage is to access another company’s intellectual property, product specifications or formulas, information on business plans or any data that will give them a commercial advantage.

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| **Example**  In 2014 US authorities arrested and charged a Chinese woman with stealing trade secrets. She, along with six others, had been stealing valuable inbred corn seeds from Pioneer, Monsanto and LG Seeds.  Inbred seeds are used to create the hybrids sold to farmers. Companies spend millions of dollars on research to produce drought and insect resistant strains that boost yields and their development is a closely guarded secret.  The group had tried to smuggle the stolen seeds out of the US by hiding them in popcorn boxes and subway napkins. |

**Who are the types of attackers?**

***Extortionist***

The main driver for the extortionist is financial gain. They usually target high profile companies who won’t want to risk negative publicity.

Extortionists don’t want to be caught and will try to avoid being exposed.

***Opportunist***

An opportunist is someone “in the right place at the right time”. They are often an employee or owner of a business that has identified an opportunity to make a profit. They will have access to potential sites for attacks and some technical knowledge.

They may be driven by the risk of failure e.g. substituting cheap cuts in order to meet supply contracts, or to avoid financial loss or bankruptcy.

***Extremist***

The extremist usually attacks for ideological reasons, their main driver is to disrupt business operations and cause reputational damage.

Extremists aren’t afraid of being found out and are more like to see failure as a deterrent rather than being caught. They want to publicise their cause and may either inadvertently or directly cause harm to the public.

***Irrational individual***

This type of attacker has no rational motive for the attack. Their behaviour is unpredictable, and the attack can either opportunistic or well planned.

***Disgruntled individual***

The main drivers for the disgruntled individual are to get revenge or cause embarrassment and financial loss, they don’t usually want to cause harm to the public.

A disgruntled individual will have expert knowledge of the operation and access to areas where they can initiate the attack.

***Hacktivist and other cyber criminals***

Hacktivists may have criminal motives (e.g. ransomware attacks), but they may also just want to demonstrate their ability to bypass computer security systems. IT expertise is an obvious factor.

***Professional criminals***

The drive for professional criminals is financial gain. Often professional criminals will operate in other industries and the fraud will be more complicated and take place over a longer time.

Professional criminals are usually well organised and can be difficult to apprehend. Although not usually employed in the industry, they will know people who they can use to gain access to the supply chain.

If successful, professional criminals are likely to repeat the food fraud therefore having a larger impact on the food supply chain.

**Bibliography**

These publications were used to develop this training material.

Andriessen, E.H., 2006, *Meat Safety Quality and Veterinary Health in Australia*, eighth edition, Penny Farthing Publishing PO Box 3322, Port Adelaide South Australia 5015

Agriculture and Resource Management Council of Australia and New Zealand, AS4696:2023 *Australian Standard for the hygienic production and transportation of meat and meat products for human consumption*, CSIRO publishing, Collingwood, Vic. The following can be downloaded from the Department of Agriculture website.

* Export Control (Meat & Meat Products) Orders 2005
* Meat Manual Volume 2 – Requirements for overseas countries
* Construction and Equipment Guidelines for Export Meat, second edition
* Department of Agriculture Meat Notices

Meat and Livestock Australia:

* Quality assurance resource disc
* *Red meat hub resource disc*
* *Guidelines for the safe manufacture of smallgoods*

**Additional resources**

Registered Training Organisations (RTOs) should refer to the Unit-by-Unit listing of resources on the MINTRAC website [www.mintrac.com.au](http://www.mintrac.com.au) for additional resources to support the delivery of this Unit.

RTOs which develop or identify additional resources are encouraged to advise MINTRAC so that these can also be added to the Unit-by-Unit listing.

MINTRAC training modules

* AMPA3071 Implement food safety program
* AMPCOR402 Facilitate Quality Assurance process
* PMLCAL400A Perform standard calibrations
* AMPCOR202 Facilitate hygiene and sanitation performance

Meat and Livestock Australia

* Quality assurance resource disc
* *Red meat hub resource disc*
* *Guidelines for the safe manufacture of smallgoods -booklet*

(Available from publications at [www.mla.com.au](http://www.mla.com.au))

Codex Alimentarius - Codex Alimentarius Alinorm 97/13A, Appendix II

[www.codexalimentarius.net](http://www.codexalimentarius.net)

HACCP alliance website\_<http://haccpalliance.org>

FSIS HACCP website – <http://www.fsis.usda.gov>

NEW Zealand Food Authority- [http://www.nzfsa.govt.nz/animal products/haccp/index.htm](http://www.nzfsa.govt.nz/animal%20products/haccp/index.htm)

Canadian Food Inspection Agency – <http://www.inspection.gc.ca>

1. Also known as the ‘point of maximum crystallisation’. [↑](#footnote-ref-1)
2. GS1 Australia is a not-for-profit organisation that locally administers the global multi-industry system of identification and communication for products, services, assets and locations - the GS1 System. [↑](#footnote-ref-2)
3. Australian Red Meat Industry *Technical Fact Sheet - Variable Weight Carton Label*, available at <http://www.gs1au.org/industry/meat.asp> [↑](#footnote-ref-3)
4. Australian Red Meat Industry *Technical Fact Sheet - Variable Weight Carcase Label*, available at <http://www.gs1au.org/industry/meat.asp> [↑](#footnote-ref-4)
5. Australian Red Meat Industry *Technical Fact Sheet - Pallets Labels*, available at <http://www.gs1au.org/industry/meat.asp> [↑](#footnote-ref-5)
6. Australian Red Meat Industry *Technical Fact Sheet - the electronic Messaging for Cattle and Sheep National Vendor Declaration (eDEC) System* <http://www.gs1au.org/industry/meat.asp> [↑](#footnote-ref-6)
7. Australian Red Meat Industry *Technical Fact Sheet - the electronic Meat Transfer Certificate*

   *(eMTC)* <http://www.gs1au.org/industry/meat.asp> [↑](#footnote-ref-7)