**AMPQUA402**

Maintain good manufacturing practice in meat processing

**Training support materials**

**Acknowledgement**

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Training support materials for AMPQUA402 Maintain good manufacturing practice in meat processing

Good Manufacturing Practices

What are good manufacturing practices (GMPs)?

A basic principle of GMP is that: quality cannot be tested into a batch of product.

[Good Manufacturing Practices (GMP)](https://www.gov.uk/guidance/good-manufacturing-practice-and-good-distribution-practice) are guidelines and procedures designed to ensure the safety and quality of meat products. These guidelines and procedures apply to all aspects of meat production. The good manufacturing practices if followed will ensure the safety and the quality of the meat produced.

These aspects covered by good manufacturing are included in a meat processing company’s Approved Arrangement and quality assurance system.:

GMP will include those practices that ensure the product meets food safety requirements and specifications. GMP are an integral part of an Approved Arrangement and cover:

* animal supply
* animal handling
* slaughtering
* processing
* packaging
* product specification
* refrigerated storage
* dispatch and transport.

The main objective of GMPs is to reduce the risks associated with food production and ensure that the food products are safe and high-quality. GMP helps a meat processing company achieve their animal welfare, product hygiene, regulatory and WHS objectives.

GMPs which include good hygienic processes are documented in the company’s Approved Arrangement/ QA Program in the:

* work instructions
* Standard Operating Procedures
* Prerequisite Programs

Statutory and workplace hygiene requirements

What is hygiene and sanitation?

Hygiene is the systematic control of environmental conditions during processing, storage and transportation of foods so that physical, chemical and micro-organism contamination will be prevented or minimised. Sanitation is the reduction of micro-organism numbers to ‘acceptable’ levels. Sanitation usually gives better than 99.99% reduction in the numbers of micro-organisms present.

Why is hygiene and sanitation important in the production of meat at a meat processing premises?

The purpose of hygiene and sanitation is to ensure that a clean product is produced in a clean environment. This will limit the contamination of the product with food poisoning (pathogens) organisms and spoilage organisms.

Hygiene and sanitation is important to meet:

* legal requirements
* product quality
* food safety.

***Legal requirements***

Hygienic processing and its enforcement is a legislated requirement of state and territory governments, and in the case of the export meat processors, the Australian government. The minimum hygiene requirements for meat processing premises, both export and domestic are set out in the **AS4696:2023 *Australian Standard for the Hygienic Production and Transportation of Meat and Meat Products for Human Consumption*.**

Product quality equals customer satisfaction. Governments and customers are now specifying physical (for instance, a zero tolerance on faeces and ingesta) and microbial contamination standards for meat products. Failure to meet these specifications may render the product ineligible for a particular market and may jeopardise the company’s registration.

Failure to meet specifications may result in product rejections, claims, returns or complaints. Where pathogenic bacteria are present, it may result in a product recall. Affected product may need to be reworked, re-processed or discarded resulting in financial losses to the processor.

Poor hygiene and sanitation has a direct relationship with the keeping qualities of meat. Poor hygiene and sanitation during processing will result in greater microbiological contamination of meat.

Meat spoilage is the result of microbiological activity. It is characterised by:

* odour – off smells
* discolouration – greening
* slime formation – biofilm.

The more microbiological contamination of meat during processing the shorter the shelf life of the final product.

Food safety

Food safety is a major factor in food processing. Recent outbreaks around the world of food poisoning caused by adulterated meat products has focused consumer attention on the food safety standards of the meat processing industry.

Poor housekeeping and hygiene and sanitation practices may result in:

* physical contamination that may be injurious to the consumer
* microbiological contamination capable of causing illness, sometimes severe, and in extreme cases death
* chemical contamination of meat products which can cause consumers to become ill.
* The major difference between food safety and food spoilage bacteria is that food safety bacteria give no sign of their presence, no slime, no smell, no colour change and in general don't grow at fridge temperature 4 deg c whereas food spoilage bacteria do.

What needs to be overseen to ensure hygiene and sanitation requirements are met?

Important areas to oversee to ensure hygiene and sanitation requirements are met include:

* personal hygiene of all personnel
* cleaning and sanitation
* pest control
* animal control at processing premises
* operational hygiene during slaughtering, dressing and further processing
* water supply.

Personal hygiene of personnel

Food handlers may be a source of physical contamination in a number of ways, including through their:

* hair
* clothing threads
* jewellery
* cosmetics.

Meat workers are also a source of microbiological contamination in a number of ways:

* as carriers of a large number of micro-organisms – some are most certainly spoilers, some may be potential pathogens or disease causing organisms
* suffering from, or as a carrier of, a disease capable of being transmitted through meat, e.g. salmonella and hepatitis A
* A person can carry Salmonella Typhimurium and have no symptoms, except green foul smelling stools. Any person in this condition should be reported to the health authorities as it is a notifiable disease, also immediately removed from the premises until cured, and cleared by a medical professional.
* contaminating meat products with infected wounds, sores or diarrhoea, e.g. staphylococcus aureus
* acting as a vehicle for cross-contamination, e.g. animal hide to meat, floor to meat and spreading Escherichia coli
* indirect food handlers such as maintenance staff may cross-contaminate food contact surfaces from their clothing or tools.

Cleaning and sanitation

The processing environment is a potential source of physical, chemical and biological contaminants. Inadequate cleaning of:

* processing areas and equipment can lead to physical and microbiological contamination of product
* toilet blocks and amenities can lead to physical and microbiological contamination of product through cross-contamination by food handlers
* product contact surfaces can result in the microbiological contamination of meat and meat products.

Inadequate cleaning and sanitation techniques and/or practices may result in chemical contamination due to residues being left on surfaces that the product comes in contact with.

Food scraps will also attract pests, which are a source of physical and microbiological contamination.

This is the main reason for cleaning footwear when exiting the ante room.

Animal hygiene

Animal entering the supply chain need to be as free as is possible of contamination such as dags and mud. Cattle for instance can be washed prior to slaughter if they are excessively soiled and put up last to avoid contaminating the processing area.

Pest control

Pests (insects, mice, rats, pigeons, feral cats etc) pose a potential source of physical (droppings, body parts, etc.) and microbiological (e.g. salmonella) contamination. Pesticides used to control pest activity are also a potential source of chemical contamination, so should be used carefully according to the manufacturer’s instructions.

Animal control at processing premises

Uncontrolled work animals, including horses, dogs, sheep and goats are a potential source of physical and microbiological contamination in and around the processing premises.

Operational hygiene during slaughtering, dressing and further processing

Incoming animals are a major source of physical and microbiological contamination. The outer surface of the hide, the contents of the digestive tract, excretions from the urinary tract and secretions from the reproductive system are all loaded with spoilage micro-organisms and potential pathogenic micro-organisms, including salmonella, E. coli.

The hygiene challenge during slaughtering and dressing is to minimise the carcase contamination from the hide/pelt removal and the evisceration process. By practicing hygienic dressing techniques, the processor can minimise the physical and microbiological contamination of the meat.

Practices should also focus on what to do when contamination does occur, to prevent further cross-contamination from occurring.

Product handling and storage practices during chilling, boning and freezing can result in further microbiological contamination and/or proliferation of micro-organisms after slaughter and dressing.

Water supply

Untreated, non-potable water is a potential source of physical and microbiological contamination to meat. Water must be treated usually by chlorination before it is used in meat processing premises. In some circumstances, non-potable water is used to wash down yards. It may also be used as a pre-wash on dirty animals. In this case, non-potable water should be rinsed off with potable water prior to the animal being slaughtered.

Hot water greater than or equal to 82oC is also used as a sanitising agent in the meat processing premises. Cooler temperatures may be used in some circumstances if they have been validated and approved by the regulator.

Where can you find the meat industry’s statutory hygiene and sanitation requirements?

Australian Standards

The***AS4696:2023 Australian Standard for the Hygienic Production and Transportation of Meat and Meat Products for Human Consumption*** is the basis for all food safety legislation in Australia, both export and domestic.

This standard applies to production and hygiene quality control of meat from animals processed for human consumption at all registered premises in Australia, including boning rooms and other further processing premises producing chilled or frozen fresh meat, but excluding meat retail premises.

All meat processing premises must comply with this Standard and is the Standard that State regulators use to assess domestic premises compliance with regulatory requirements.

In addition to the requirements of this Standard, domestic and export premises must comply with State legislation that covers animal welfare, environment and workplace health and safety. This additional legislation will impact on the GMPs employed by premises processing animals.

Export requirements

In addition to the Australian Standard export registered premises must fulfil the regulatory requirements of the ***Export Control Act 2020***and the ***Export Control (Meat & Meat Products) Rules,2021*** and ***Australian Government Approved Arrangement guidelines***. The requirements of the Australian Export Meat Inspection System will also impact on the work instruction and SOPs of a meat processing premises.

What is required by the Australian Standard?

The **AS4696:2023 *Australian Standard for the Hygienic Production and Transportation of Meat and Meat Products for Human Consumption*** *–* is divided into 8 parts and three schedules.

It is important to note that the standard is not prescriptive and that it describes the outcomes required, leaving it up to the company to work out how it will achieve the outcomes.

The only prescriptive section is Schedule 1 where personal hygiene requirements are detailed.

In general Good Hygiene Practices (GHPs) based on previous experience and industry norms are expected to apply.

The key to the whole standard is that the meat must be wholesome. The definition of wholesome in the *standard* is:

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 *Australian Standard* is divided into the following sections. Only the required outcomes are stated. For further information the trainee must read the Standard itself.

PART 1 INTRODUCTION

1 PRELIMINARY

This is a list of definitions. The list of definitions has been expanded and should be read carefully to fully understand the meaning of various parts of the standard.

2 APPLICATION

This describes the scope of the standard. It includes all aspects of meat production from the animal through slaughter and boning to further production of smallgoods etc but not retail. Retail butchers are included if they produce smallgoods.

PART 2 WHOLESOMENESS AND OPERATIONAL HYGIENE

3 MANAGEMENT OF WHOLESOMENESS

**Outcome required**

***Management and production practices and the implementation of HACCP ensure the production of meat and meat products that are wholesome***.

This part introduces the concept of an approved arrangement. The Approved Arrangement is required to be a HACCP based QA system that covers each stage of the production.

4 OPERATIONAL HYGIENE

**Outcome required**

Operational hygiene process controls ensure the production of meat and meat products that are wholesome.

5 CROSS CONTAMINATION

**Outcome required**

Meat and meat products are not contaminated.

PART 3 SLAUGHTER AND DRESSING OF ANIMALS

6 THE SUPPLY AND ADMISSION OF ANIMALS FOR SLAUGHTER

**Outcome required**

Animals are sourced from holdings where the management of animals ensures that the wholesomeness of meat and meat products derived from the animals is not jeopardised.

Animals affected by a disease or other abnormality, do not contaminate other animals or jeopardise the wholesomeness of meat and meat products.

7 ANIMAL WELFARE

**Outcome required**

The minimisation of the risk of injury, pain and suffering and the least practical disturbance to animals

The main guideline for this element is *The Australian Livestock Processing Industry Animal Welfare Certification System (AAWCS),* as well as *the Model Code of Practice for the Welfare of animals.*

8 ANTE-MORTEM INSPECTION AND DISPOSITION

**Outcome required**

Only animals fit for slaughter for the purpose of producing meat and meat products for human consumption are slaughtered.

9 SLAUGHTER AND DRESSING

**Outcome required**

Slaughter and dressing is to be done in a way that:

(a) reduces the risk of contamination of carcases and carcase parts to a level that ensures the wholesomeness of meat and meat products is not jeopardised

(b ensures an accurate post-mortem disposition can be applied to carcases and carcase parts.

10 POST-MORTEM INSPECTION AND DISPOSITION

**Outcome required**

Unwholesome meat is excluded from the human food chain and disposed of separately.

PART 4 PROCESSING

11 CHILLING AND FREEZING

**Outcome required**

The chilling and freezing of meat maintains, and does not jeopardize its wholesomeness.

12 THAWING, TEMPERING, BONING AND OTHER PROCESSING OF RAW MEAT

**Outcome required**

The thawing, tempering, boning and other processing of raw meat does not jeopardize its wholesomeness.

13 FURTHER PROCESSING

**Outcome required**

The further processing of meat and meat products ensures and does not jeopardize their wholesomeness.

PART 5 PACKAGING, STORAGE AND HANDLING

14 PACKAGING

**Outcome required**

During packaging the wholesomeness of meat and meat products is not jeopardized.

15 STORAGE AND HANDLING

**Outcome required**

During storage and handling meat and meat products are not contaminated and their wholesomeness is not jeopardized.

PART 6 IDENTIFICATION, TRACEABILITY, INTEGRITY AND RECORD KEEPING

16 IDENTIFICATION, TRACEABILITY AND INTEGRITY

**Outcome required**

Meat and meat products are accurately identified.

Meat and meat products that should be recalled can be recalled.

17 ANIMAL FOOD AND PHARMACEUTICAL MATERIAL

**Outcome required**

Animal food is identified as animal food and segregated from other meat and meat products.

Pharmaceutical material is identified as pharmaceutical material and segregated from other meat and meat products Animal food and pharmaceutical material that should be recalled can be recalled.

18 RECORD KEEPING

**Outcome required**

Documents are kept to enable it to be ascertained whether:

(a) meat and meat products are wholesome; and

(b) the matters specified in this Standard are met.

PART 7 PREMISES, EQUIPMENT AND ESSENTIAL SERVICES

19 PREMISES AND EQUIPMENT

**Outcome required**

Premises and equipment facilitate the production of meat and products that are wholesome and do not jeopardise their wholesomeness.

Premises & equipment minimize risk of injury, pain & suffering & causes the least practicable disturbance to animals.

20 HYGIENE AND SANITATION FACILITIES

**Outcome required**

The provision of hygiene and sanitation facilities that enable the hygienic production of meat and meat products.

21 ESSENTIAL SERVICES

**Outcome required**

The essential services provided:

(a) enable operations to be carried out effectively; and

(b) maintain and do not jeopardize the wholesomeness of meat and meat products.

PART 8 TRANSPORTATION OF MEAT AND MEAT PRODUCTS

Note: These requirements do not apply to the transport of animals, but only to the transport of meat. Animal transport is covered by “Truck Care”, the industry based quality assurance system, designed to ensure that animals are carried humanely and cleanly to meat processing premises. Requirements are detailed in the model codes of practice for animal welfare. Reference should also be made to the ***Model Code of Practice for the Welfare of Animals: Land Transport****.*

22 MANAGEMENT OF WHOLESOMENESS

**Outcome required**

Management and handling practices ensure that the wholesomeness of meat and meat products is maintained during transport.

23 OPERATIONAL HYGIENE

**Outcome required**

Operational hygiene process controls result in the transportation of meat and meat products that are wholesome.

24 WHOLESOMENESS AND IDENTIFICATION DURING TRANSPORT

**Outcome required**

During transport:

(a) The wholesomeness of meat and meat products is maintained and not jeopardized; and

(b) The identification of meat and meat products is retained.

25 MEAT TRANSPORT VEHICLES AND EQUIPMENT

**Outcome required**

Meat transport vehicles and equipment facilitate and do not jeopardise the wholesomeness of meat and meat products.

THE SCHEDULES

These are three schedules in this standard:

Schedule 1 Personal hygiene

Schedule 2 Procedures for post mortem inspection

Schedule 3 Ante-mortem and post- mortem dispositions.

Personal hygiene is so important in meat processing that it was decided to spell it out in more detail in Schedule 1.

What is covered in the Export Control (Meat and Meat Products) Orders?

For export, meat premises are supervised by the Department of Agriculture, the ***Export Control (Meat & Meat Products) Orders***call up the ***Australian Standard***as the basis for all hygiene and meat inspection matters.

The additional requirements in these orders are primarily for product integrity, certification and meeting overseas countries requirements.

These requirements are covered in detail in the training material for *AMPLDR405 - Oversee export requirements*

What are the requirements of an Approved Arrangement in an export premises?

The Department of Agriculture has published guidelines for the development of an Approved Arrangement. The Approved Arrangement contains the work instructions, SOPs and Prerequisite programs which describe the GMP employed in the meat processing premises. Published in March 2021 the guidelines are the most up to date advise on how to document the company’s HACCP based QA system.

<https://www.agriculture.gov.au/biosecurity-trade/export/controlled-goods/meat/elmer-3/aa-guidelines-meat>.

The Guidelines are divided into the various stages of production and the outcomes expected and checklists to assess if GMP are in place and achieving the required outcomes.

The guidelines also nominate the range of pre-requisite programs that should support the Work Instructions and SOPs. The Guideline defines pre-requisite programs as: “general sanitation, hygiene, testing and maintenance programs applied prior to the application of HACCP, ensuring that the HACCP process can focus on issues directly related to food safety and including SSOPs”

The pre-requisite programs can include:

* Pre-Operational Sanitation
* Operational Sanitation
* Personal Hygiene
* Waste Disposal
* Water Supply
* Pest Control
* Structure and Maintenance
* Control of Hazardous Substances
* Sourcing of Animals for Slaughter
* Purchasing
* Animal Welfare
* Slaughter (includes Dressing)
* Inspection
* Boning
* Further Processing
* Temperature Control
* Calibration
* Sampling Programs.

What is HACCP?

The balance of this document will focus on the development of the HACCP system. It has been assumed that the elements required to be in place to allow sustainability of the system are in place. These elements will be referenced throughout the document where needed.

The Hazard Analysis and Critical Control Point System or HACCP (pronounced ‘hass-up) is a system based on prevention. It is both a logical and scientific approach to controlling **food safety** problems throughout the production process. HACCP is an essential element of a food industry quality management system.

It 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:

* microbiological hazards
* chemical hazards
* physical hazards.

Sources of hazards include raw materials, the processing equipment, staff, processing procedures, handling procedures, storage conditions, etc.

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 through among other processes Good Manufacturing Practices.

Where are workplace GMPs documented?

The workplace quality management system will contain the hygiene, sanitation and quality requirements specific to the workplace. These requirements can be found in the ‘Approved Arrangement’ based on HACCP, regulatory and importing country requirements.

The HACCP program will identify steps in the process – from animal receipt to final product dispatch, where meat safety contamination and quality hazards can occur. The HACCP program will also establish procedures for preventing the occurrences of hazards and corrective actions should hazards occur.

The measures for the prevention of meat safety contamination hazards and the corrective action necessary when meat safety hazards occur, will normally be detailed in an operator work instruction.

The Standard Operating Procedures (SOPs) support the HACCP program by identifying and controlling actions and activities that pose potential hazards to meat safety, but are peripheral to the process but cover potential meat safety contamination hazards controlled by establishing procedures for among aspects of production:

* personal health and hygiene
* cleaning and sanitation
* pest control
* waste disposal
* water supply.

SOPs are generally supported by more detailed operator work instructions.

What are the consequences of not complying with statutory and workplace hygiene and sanitation requirements?

Potential adverse consequences of not satisfying hygiene and sanitation requirements include financial loss due to:

* increased audit frequency resulting from failure to demonstrate consistent conformance with statutory requirements
* scrap, rework, reinspection, customer claims or product recall because of food spoilage
* loss of business due to reduced shelf life
* loss of business because of customer dissatisfaction resulting from food poisoning
* financial loss due to public liability claims resulting from food poisoning.
* in the extreme, loss of registration (domestic and/or export) as a meat processor due to failure to comply with regulatory requirements. Auditors assessing a firm’s meat safety program on behalf of a regulatory authority, state or commonwealth, or a customer, may withdraw the operator’s registration to process, where non-compliance with the requirements would seriously affect meat safety.

These consequences can seriously affect the viability of an organisation. Loss of consumer confidence resulting from a food poisoning outbreak put Garibaldi Smallgoods into liquidation within a fortnight of being identified as the source of the outbreak.

What are employer and employee responsibilities in complying with hygiene and sanitation requirements?

Management

Is responsible for:

* establishing and maintaining a workplace culture that focuses on and promotes good hygiene in all aspects of all operations
* supplying and maintaining adequate resources to enable all employees to maintain personal health and practice personal hygiene.

Quality assurance staff/production area supervisors

Have the responsibility to:

* monitor the hygiene and sanitation practices to ensure conformance with procedures
* monitor hygiene resources to ensure operators can comply with procedures
* initiate corrective action where non-conformities are detected
* train new employees and retrain or upskill existing employees.

Meat processing premises employees

Have the responsibility to:

* perform all duties in accordance with the requirements of hygiene and sanitation procedures
* report deficiencies with hygiene resources which prevent or hinder conformance with the requirements of hygiene and sanitation procedures.

Monitor hygiene and sanitation performance

Why monitor hygiene and sanitation?

Hygiene and sanitation need to be monitored to ensure compliance with statutory and workplace requirements.

Monitoring will identify contamination or non-compliance so that corrective action can be taken to prevent the production of contaminated or non-conforming product.

Analysis of monitoring results will identify trends, which may indicate that the hygiene and sanitation programs are moving out of control so that corrective measures can be made before contamination reaches an unacceptable level. These analytical tools are covered in detail in Attachment One*.*

How do you monitor hygiene and sanitation?

Activities necessary to monitor compliance with hygiene and sanitation requirements include:

* sampling of product
* examination of process
* inspections of premises, personnel and equipment.

Monitoring of hygiene and sanitation usually consists of three techniques:

* organoleptic or sensory evaluation
* measurement
* microbiological testing.

Organoleptic monitoring

These methods include:

* visual inspection
* touch, feel
* smell.

Measurement

Measurements include:

* temperature checks
* chlorination measurements.

Microbiological testing

Includes replica or contact methods and swab methods.

Replica or contact methods

A suitable growth medium is pressed into contact with the surface to be tested. A proportion of the organisms present on the surface will become attached to the growth medium and, on subsequent incubation, will grow into visible colonies. These systems pick up about 30% of the organisms present.

Agar slice

Agar slice methods use an agar gel contained in a syringe or a plastic skin. To test a surface, the syringe is advanced until the agar extends about 3 mm beyond the end of the barrel. The medium extending beyond the end of the barrel is sliced off with a sterile knife. The agar is extended by 5 mm and the new agar surface is gently pressed on the surface to be tested. The portion of agar making contact is then sliced off with a sterile knife, placed face up in a petri dish and incubated.

Contact plates

Contact plates are modified petri dishes, which are designed for direct contact evaluation. The centre of each contains a suitable growth medium, which is gently pressed onto the surface being tested.

Contact petri film

Contact petri film is a sterile thin film of agar adhered on a small sheet of backing material. The cover strip is pulled off and the agar pressed gently onto the surface to be tested. It has the advantage that it has a flexible backing allowing testing of non-flat surfaces.

Dip slides

Dip slides with agar on the surface come ready to use in sterile containers. The dip slide is removed and pressed onto the surface to be tested and returned to the container for incubation.

Swab methods

These pick up only about 10% of micro-organisms on the surface as compared with the contact methods which are closer to 30%. Swab methods have the advantage that they can be used in a wide range of surfaces. The US ‘Megaregs’ specify the swab method using a sponge.

Agar plate swab

Agar plate swab methods use a sterile swab moistened with a sterile solution such as peptone solution. The swab is streaked over the surface to be tested in two directions, north to south, then east to west. The swab is then streaked over the surface of an agar plate or petri film. The area tested and the area of the agar should be approximately the same. The agar plate or petri film is then incubated.

Rinse methods

Rinse methods followed by counting of organisms in rinse water give the highest recovery of contaminating micro-organisms. Rinse methods are useful in evaluating the effectiveness of Clean in Place (CIP) cleaning systems.

Protein tests

While not a microbiological test, protein tests such as ATP (Adenosine Tri-Phosphate) are an alternative, rapid test for hygiene monitoring. The test uses food residue (measured by ATP) as an indicator of cleanliness. ATP equipment is portable and results are in real-time enabling re-cleaning if necessary.

What needs to be monitored?

Monitoring personal health and hygiene

Organoleptic evaluation

This includes:

* visual inspection of personal equipment, before work and at breaks, to check for clean pouches, clean knives, clean steels, clean mesh gloves and clean aprons
* visual inspection of personal practices to check for are adequacy of hand washing on entry to processing areas, clean footwear, and clean protective clothing
* visual inspection of compliance with standard operating procedures and work instructions for personal hygiene.

Microbiological testing

Preoperational random testing is done on machinery likely (but not exclusively) to contact the product. This is a verification of the premises cleaning and sanitising process.

Pre-operational microbiological testing is conducted on boots, pouches, knives, steels, mesh gloves and aprons.

Monitoring cleaning and sanitation

Organoleptic evaluation

A pre-operational visual inspection is conducted to monitor cleaning and sanitation.

The general appearance of the work area is checked. Contamination should not be visible under good lighting. Particles of meat and/or fat should not be present.

Other checks include:

* a clean white cloth or tissue should not become discoloured when rubbed over the surface of clean stainless steel
* all surfaces should be dry before work, because of cleaning operations the previous night
* handwashing facilities should be adequately supplied with liquid hand soap and, where hand drying facilities are supplied, receptacles for waste paper.

Other senses are also used in pre-operational inspection of the premise or work area. These include making sure that:

* work surfaces are not greasy or rough when rubbed with the fingers
* no objectionable odours are detected.

Measurement

Pre-operational checks are made to ensure:

* hot water and steriliser units are operating at greater than and or equal to 82oC
* hand wash water is between 34 and 45oC.

General

General monitoring includes checks to make sure that:

* cleaning chemicals in use are approved
* cleaning chemicals are handled, used and stored to prevent contamination of meat
* amenities, storage areas, inedible areas, lairages, gardens and premises environs are clean.

Monitoring Pest Control

Organoleptic evaluation

Organoleptic evaluation methods are used to monitor pests. Premises are visually inspected for:

* access points – screens, drains, eaves etc.
* potential shelter or nesting sites for pests
* potential food sources
* control measures – bait stations, insectocutors
* evidence of pest activity – bait stations, droppings, damaged packaging, tracks, body parts, egg cases etc.

Monitoring waste disposal

Organoleptic evaluation

A visual inspection of premises during processing is used to monitor waste disposal including checks that:

* floor areas are cleaned on a regular basis and when contaminated
* build ups of waste materials are removed without contact with edible product, people or equipment
* disposal of process consumables – e.g. bung and tail bags, hand drying towels. legging paper
* minimal use of high-pressure hoses, low-pressure high-volume water preferable to prevent splash during wash down at breaks.

Monitoring operational hygiene

Organoleptic evaluation

Visual inspection of product includes Meat Hygiene Assessment of carcases, carton meat and offals for macro-contamination in export premises.

Note: There are no procedures specified in the *Australian Standard* but there is a requirement under clause 3.6 to verify compliance with the *Standard*.

Meat Hygiene Assessment is the best system available and should thus be used on all premises - export and domestic for product and process verification.

Since 5/4/2023 meat notice 2023-01 MHA3 reform changes to Meat Hygiene Assessment for tier 2 and 3 premises have been implemented

The visual inspection of process covers:

* monitoring of critical steps and critical control points in processing for compliance with documented work instructions as required under the HACCP program in domestic premises
* Meat Hygiene Assessment of process steps for conformance with documented work instructions as required under HACCP program in export premises

Visual inspection of personnel requires the monitoring of personnel practices against SOP and work instructions, including equipment sterilisation and handwashing when required.

Microbiological testing

Microbiological testing of product surfaces is another process verification activity and includes:

* Total Viable Count (TVC) or Total Plate Count (TPC)
* The **Product Hygiene Index** (PHI) is a measure of hygienic meat production at individual export premises. The PHI and individual key performance indicators (KPIs) can be used to:
  + assess compliance with Australian regulations
  + assess compliance with importing country requirements
  + assess operational management
  + assess management capability in respect to their ability to manage new technology or processes; and
  + identify and manage non-compliance.

The PHI is a uniformly applied method to verify a premise’s ability to comply consistently including its ability to detect and resolve its own deficiencies.

* bacteriological testing requirements of the US pathogen E. coli and *Salmonella* reduction program for US listed export premises as specified by Department of Agriculture notice 96/46.

Monitoring Water Supply

Organoleptic Evaluation

Premises are visually inspected for the use of potable and non-potable water and the cleanliness of in-premises potable water storage tanks.

Measurement

Specified requirements are measured. These are:

* steriliser water temperature higher than or equal to 82°C
* handwash temperature between 35°C and 45°C.
* free residual chlorine levels.

Microbiological testing

Microbiological testing includes the collection of water samples for microbiological analysis.

What monitoring records should be kept?

All monitoring activities need to be recorded – conforming as well as nonconforming. Record keeping activities could take a number of forms, such as monitoring sheets and checklists.

Accurate honest records are the companies best defence against a n unsubstantiated claim by a customer regarding food poisoning. Records show that while the product was under your control it was wholesome. Once the product leaves your control it still has your name on it.

The format will be workplace specific.

Daily monitoring records should be kept for:

* personal health and hygiene
* cleaning and sanitation
* operational hygiene including MHA product and process assessment
* water chlorination records.

The frequency of monitoring activities will vary, depending on premises performance. For example, pest bait stations would not need to be checked daily if pest control activities demonstrated pests were under control.This monitoring activity could be reduced to weekly or even monthly checks.

Simple pre-operational hygiene monitoring sheet

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***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 |  |  |  |  |  |  |
| Lunchroom |  |  |  |  |  |  |
| Locker room/Toilets |  |  |  |  |  |  |
| Ancillary Area |  |  |  |  |  |  |
| Loadout area |  |  |  |  |  |  |
| Carton storage |  |  |  |  |  |  |
| Ingredients storage |  |  |  |  |  |  |
| Chemical store |  |  |  |  |  |  |
| Waste collection area |  |  |  |  |  |  |
| **Date/Day** | **Defect** | **Corrective actions** | **Sign** |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

Respond to hygiene and sanitation problems

What corrective actions should be taken?

Corrective action must be taken when monitoring shows that there is a deviation from statutory and/or workplace requirements.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
* **determine cause and fix** – 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 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 |

Critical deviations, for example when anoperator picks a rump up off the floor and throws it onto boning table with other product, will require immediate corrective action

Major deviations will require quick corrective action but some allowance may be given in the urgency of the corrective action. For example, where boning room temperatures rise above 10°C, production may be allowed to continue for up to two hours whilst the problem is rectified.

Minor deviations will require corrective action; however rectification is not urgent. An example is mould on the ceiling in the carton chiller.

What do we do when breaches in hygiene and sanitation standards are due to workers?

The least productive response to this situation is shouting, finger waving and threatening. If statutory requirements or workplace procedures are not being followed it is important to analyse why. The reasons could include:

* the employee does not know the procedure or requirement
* the information or training given to the employee was inadequate or wrong
* the work instruction is not clear
* the nature of the task makes it difficult to comply with the hygiene requirements
* the employee is being difficult for other unrelated reasons.

It is important to start from the position that most meat workers will follow instructions and procedures if:

* they know about them
* are shown how to follow them
* understand why it is important to follow these procedures
* they have the resources and opportunities to follow procedures.

It is only after we are sure that the worker has been given the knowledge, skills,resources and opportunity to comply with the procedure, that we can then regard the problem as an attitude or discipline problem.

Employment legislation Australia-wide requires supervisors to follow a standard procedure of counselling and warning workers. Therefore, along with other forms of disciplinary problems, consistent breaches of hygiene and sanitation must be dealt with in a calm, consistent and documented fashion.

How can you evaluate or interpret monitoring results?

Monitoring results should be reviewed on a weekly and monthly basis, with a view to collating results. A range of tools can be used to interpret results. Control charts with statistically derived control limits are probably the most used tools in meat processing.

All data should be reviewed with an aim of continuous improvement.

What is required to implement continuous improvement?

Quality improvement is usually described as taking place within the Plan, Do, Check, Act model. This model is also known as the Deming cycle. The PDCA model requires a team approach to be effective.

|  |
| --- |
| PDCA cycle |

Planning stage (plan)

* select the project or problem
* clearly define the problem/project and the aim of the problem/project
* conduct a mini-investigation of the project
* establish an action plan
* register the project with facilitator/management.

Activity stage (do)

* probe the cause and/or solutions of projects or problems and trial solutions
* collect information
* analyse and evaluate the information
* decide on the best possible solution
* communicate the solution
* trial and test the solution.

Validation stage (check)

This stage is used to validate improvements.

* collect data from tests/trials
* analyse and verify solutions
* if valid go to act phase, if not, review the problem.

Implementation stage (act)

* prepare a report for management
* present the report to management
* the solution is approved or rejected
* if approved implementation is initiated
* the solution to the problem or quality improvement plan is put into practice.

Follow-up stage

* after the plan has been put in place, evaluate the new results
* standardise the Quality Management System – write new procedures, provide training, etc.
* plan – continue the PDCA cycle.

Note: The PDCA cycle can be applied to all issues where corrective action is required.

Evaluate results of microbiological testing

Why is microbiological testing required to be performed?

The AS4696:2023 *Australian Standard for the Hygienic Production and Transportation of Meat and Meat Products for Human Consumption* requires management of a meat business to verify that the requirements of the standard are being met (Clause 3.6).

Verify *means to apply methods, procedures, tests and other evaluations in addition to monitoring to determine whether a requirement is complied with or met.*

The purpose of verification procedures is to ensure that the HACCP System is working correctly and therefore prevent food safety hazards.

The aim of verification is to prove CCPs are under control and that the pre-requisite programmes are working. Verification activities are carried out in addition to monitoring procedures.

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

Verification should be a scheduled activity and may include the following activities outlined in the table below.

|  |  |
| --- | --- |
| **Verification activities & schedule (example only)** | |
| **Activity** | **Frequency.** |
| * internal audit of HACCP system. | * quarterly |
| * review of monitoring records. | * daily |
| * management review of the system | * every six months |
| * review of deviations & records | * each deviation |
| * random microbiological analysis as appropriate. Sample selection must be statistically based. | * random |
| * random checks of compliance with critical limits. | * random |

An important part of verification is microbiological testing.

What microbiological testing is required to be performed?

All meat processing premises in Australia are required to have in place a microbiological testing programme as part of process control verification. The requirement is for total viable counts (TVC) to be taken and the prevalence of generic E. coli determined. Total viable counts are also known as Standard Plate Counts (SPCs).

The main microbiological testing that is required to be performed is on:

|  |  |
| --- | --- |
| Product | to verify dressing procedures |
| Working surfaces | to verify cleaning procedures |
| Water | to verify its continuing suitability for edible purposes |

Product testing

The basic requirements for product testing are:

**Beef:** two by 100 cm2 sites, one on the flank and the other on the brisket.

Three sites are sampled on export premises, the extra site being on the rump.

**Sheep, Calves, goats and Deer:** three sites of 25 cm2 each, the flank breast and midloin.

**Pigs**: Three sites of 100 cm2 each, the jowls, brisket & ham.

**Kangaroos and wild boar**: two sites of 25 cm2 each one on the shoulder the other on the outside of the leg.

**Ratites (Emus and Ostriches):** three sites of 25 cm2 each, the inside and outside of the legs and the pelvis.

Total viable counts and the presence of E. coli are the required tests. Export premises may also have to test for salmonella.

**Note:** Game meat sampling is done by the excision method.

Suitably trained personnel can do testing in-house so long as standard testing techniques are used and they can demonstrate competency at audit.

Samples may be taken immediately after slaughter or after chilling prior to load out. Samples collected immediately after slaughter are useful in assessing the slaughter process. Samples collected after chilling are useful in assessing the total process. Whichever is chosen, the sampling time must be maintained to obtain meaningful data. This is because the number and types of organisms can vary according to the time of sampling.

Samples collected immediately after slaughter tends to show a higher level of E. coli and Salmonella than samples collected after chilling. This is because the chilling process tends to neutralise some of these organisms. On the other hand, the longer the delay between slaughter and sampling the higher the TVC will be as some organisms such as Staphylococci and listeria will grow quite well at some chiller temperatures.

To obtain meaningful figures that can be used in premises all aspects of sampling and testing must be done as consistently as possible. Well-documented instructions, good training and careful attention to detail are the best way to achieve this. To maintain consistency, ideally only one person should do sampling and testing.

Microbiological testing of meat cannot be used to judge the wholesomeness of individual pieces of meat or to confirm absence or presence of certain organisms. The reason for this is that microbiological testing of meat is a poor method of assessing the food safety risk of individual pieces of product for a number of reasons.

* The swabbing of two or three sites of 100 square cms each, on one carcass in 300-1000 does not indicate whether that carcass or lot of carcasses is safe for human consumption. It is a bit like taking a postage stamp size photo of a part of an elephant and trying to decide what it looks like from that one shot. A true picture only appears after many shots.
* The point in the process where the sampling is performed can also have an effect on the number of organisms. If done soon after slaughter the organisms will not have adhered well to the meat so more will be removed during swabbing than if done two hours later. If left until the next day many coliforms will have been killed by the cold but the staphylococci will have had a chance to grow.
* Testing techniques vary between various individuals e.g. some people swab the surface harder than others and therefore remove more organisms.
* There is some variation in the various testing systems available commercially.

Microbial testing can only be used as a general indicator of food safety. This testing can only be used over a period, to assess trends and to compare the performance of a particular premises against the Australian base line.

The export sector had to put in place a slightly different programme, called the ESAM program, because the program needed to meet the requirements set by the United States Food Safety and Inspection Service. This was done to maintain our export markets to that country.

In addition, the Product Hygiene Index (PHI) is a measure of hygienic meat production at individual export premises.

KPIs for the PHI have been selected or developed based on their ability to address hazards identified through an industry wide whole of chain risk assessment of the Australian red meat production system against the requirements of the AS4696:2023 Australian Standard. That assessment has identified residues in incoming animal and contamination by faeces and ingesta (providing a vehicle for transfer of pathogens to the product) either directly or indirectly as being the main wholesomeness issues confronting the red meat sector in Australia. The issue of residues is adequately addressed through the National Vendor Declaration system and verified by the National Residue Survey and other targeted programs. Therefore, the focus is on preventing contamination and cross contamination by enteric pathogens and on the application of good refrigeration to ensure that there is minimal growth of any contaminating micro-organism in the event of undetected contamination. Refrigeration is adequately controlled through the application of the Refrigeration Index.

Some of the KPIs are an objective measure of the wholesomeness of the meat through the process chain. Others verify the microbiological quality of product produced during that process. The Product Hygiene Index is derived from the values for the individual KPIs.

Testing working surfaces (Sanitation standards)

Microbiological testing (environmental audit) of work surfaces and equipment is an essential part of the verification procedures of a HACCP based QA programme.

Note: Working surfaces include equipment and gear used by employees such as knives, pouches and steels

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

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 for how it is done.

The ***contact*** petri film system is the most common commercial method used in the meat industry in Australia as it is quick and easy to use and does not require specially trained operators to use it effectively.

The petri film has a sterile thin layer of agar impregnated with a nutrient medium and a chemical that changes from colourless to red in the presence of enzymes released by bacteria.

The cover strip is pulled off and the agar pressed gently onto the surface to be tested. It has an advantage that the flexible backing allows testing of surfaces that are not flat.

Red spots appear in the presence of microorganisms on the pad when it is incubated. The number of red spots is a semi-quantitative measure of the number of bacteria originally present.

***Swab*** methods are also commonly used but are subject to significant variability due to technique, but they are easy to perform and, unlike contact methods, can be used on uneven surfaces and in cracks and corners. Swab methods pick up only about 10% of the organisms on a surface, as compared to the contact methods. But swab methods have the advantage that they can be used on a wide range of surfaces.

To perform the test a sterile swab is moistened with a sterile solution (such as peptone solution). The swab is streaked over the surface to be tested in two directions (North to South, then East to West). The swab is then streaked over an agar nutrient gel in a petri dish. Ideally, the area size will be recorded to determine the level of contamination. The area tested and the area of the agar should be approximately the same. The petri dish is then incubated and any growth of microorganisms can be observed. Swabs may also be cultured on petri film.

Since the sponge swab method is the method that must be used for carcase meat swabbing in Australia, many companies also use swabbing for working surfaces.

***Rinse*** methods followed by counting organisms in the rinse water give the highest recovery of contaminating microorganisms. This method is commonly used in the poultry processing industry to assess the microbial status of whole birds as an indicator of processing hygiene.

Water testing

Water used to process food including meat must be potable.

Note: Potable means drinkable.

The Australian Standard defines potable as: ***Water quality that is consistent with the Australian drinking water guidelines 1996 published by the National Health and Medical Research Council.***

These standards specify that water should be no more turbid than 5 NTU (Notional Turbidity Units), meet certain chemical standards and that the bacteriological quality of water should be regularly assessed by testing for E. coli and coliforms.

The number of coliforms/ E. coli present in a water supply is used as an indicator of the degree of faecal contamination of that water supply and as an indicator of the presence of other potentially harmful organisms in the water supply.

Note - Since 2003 the assessment for coliforms is no longer mandatory to meet NHMRC guidelines since E. coli alone is considered to be an adequate assessment tool for the assessment of potability of water.

Virtually all potable water supplies supplied by municipal authorities are chlorinated, but in premises chlorination is frequently used in meat processing premises to ensure a potable supply at all times as municipal supplies cannot be guaranteed acceptable 100% of the time.

If in-premises chlorination is practiced the water must be free of coliform organisms at all times.

There are a range of other organisms that can affect the potability of water, these include enteric viruses, sulphur reducing Clostridia, Helminths and Protozoa (Giardia and Cryptosporum). Potable water is rarely tested for these organisms as it is presumed that if the indicator organisms (E. coli) are not present these will also be absent. This is true for all these organisms, other than the protozoa and helminths, which are extremely resistant to chlorination and can resist up to 1000ppm of chlorine. Fortunately flocculation and filtration as practised by most municipal authorities removes most protozoa and helminths from the water supply.

It is up to the individual premises to verify that their water supply is potable. On export premises there is a requirement to conduct a microbial test at least once a month.

Other tests including chemical analysis of the water are conducted less frequently.

Meat processing premises may request test results from their municipal authority to prove potable supply.

How should the results of microbiological testing be interpreted and used?

Product standards

The results of testing of product should be compared to the baseline survey results when judging acceptability. In broad terms these are as follows:

|  |  |  |
| --- | --- | --- |
| **CATEGORY** | **TVC/cm2 org /g** | **E. coli/ cm2 org/g** |
| Excellent | < 1000 (3 log) | None detected |
| Good | 1000-10,000 (3-4 log) | 1-10 |
| Acceptable | 10,000-100,000 (4-5 log) | 10-100 |
| Marginal | 100,000-1000,000 (5-6 log) | 10-1000 |

Companies are expected to use the data to plot run charts of their performance, to assess adverse trends and to verify the effectiveness of their HACCP programme.

Sanitation standards

The acceptable microbiological standard for cleaned and sanitised surfaces will vary according to the type of microbiological test used. Most commercial test kits have their own standards.

As an example, for a sample that has been taken by swabbing, and subsequently cultured, a sanitised surface is defined as one that is free from all harmful bacteria and has a residual bacterial count of less than 12.5 organisms per 6.3 cm2 i.e. from an area of 2.5×2.5cm swabbed.

Note that the example provided above is more typical of domestic premises. Export premises using the PHI will have different requirements.

|  |  |  |
| --- | --- | --- |
| **Surface count** | **Clean surface not sanitised** | **Cleaned and sanitised surface** |
| Less than 10 | Satisfactory | Satisfactory |
| 10 | Satisfactory | Borderline |
| 100 | Borderline | Unacceptable |
| 1000 | Unacceptable | Unacceptable |

Water Standards

If in-premises chlorination is practiced, there must be no coliforms at any test.

If chlorination is not practiced the following standards apply:

|  |  |  |
| --- | --- | --- |
| **Coliforms/100 mL** | **E. coli /100 ml** | **Rating** |
| 0-2 | 0 | Satisfactory |
| 3-10 | 0 | Suspicious |
| Greater than 10 | 0 | Unsatisfactory |
| Irrespective of numbers | 1 or more | Unsatisfactory |

The standard specifies that no sample of potable water tested should ever be rated as unsatisfactory and successive samples should not be rated as suspicious.

What corrective actions should be taken?

Corrective action must be taken when microbial testing indicates that the microbial load is outside stated standards.

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
* **determine cause and fix** – determine the root causes, then fix the problem to prevent recurrence of the nonconformity
* **document** – record the non-conformance identified during monitoring and the corrective action taken.

Product microbial quality

Microbial testing of product is not an accurate guide for the wholesomeness of individual pieces of meat or to confirm absence or presence of certain organisms. It is only useful as a long-term indicator of trends.

TVC is more useful than E. coli or Salmonella testing as there are more organisms to count to help assess trends.

Companies with results in the marginal range should aim to improve their results. In most cases product will already have been distributed by the time results have come through, so all that can be done in the way of corrective action are steps 3 and 4.

To determine the cause of an elevated TVC, a complete review of processing on the day in question is needed. Issues that should be looked at include:

* quality of incoming animals
* animal holding facilities and practices
* dressing procedures
* refrigeration
* microbiological sampling methods e.g. is some new doing it.

The results of the review should be fully documented.

If results are consistently in the marginal range a complete review of all operations is needed to determine the underlying cause and to bring the figures back into the acceptable or better range.

If results are consistently in the marginal range the rate of microbial testing should be increased until the problem is solved.

On export premises the ESAM programme (E. coli/Salmonella) requires testing for Salmonella. If Salmonella are detected within a certain number of samples, extensive corrective action is required.

See relevant Department of Agriculture notices and workplace procedures for further details.

Sanitation Standards

If the surface count of working surfaces or equipment is borderline or unacceptable, the following action should be taken:

* cleaning department advised of the finding
* working surface retested
* all results documented.

If personal equipment is involved, the person is advised to clean his/her gear more thoroughly.

Equipment or gear retested.

Problem areas or people should be targeted for more regular testing. All results must be documented.

Water Quality

The standard specifies that no sample of potable water tested should ever be rated as unsatisfactory and successive samples should not be rated as suspicious.

The relevant workplace water prerequisite programme should detail a range of options.

An unsatisfactory finding should result in immediate retesting of the water. If the problem persists further production of meat should cease until the problem is solved and the water is again assessed as being potable.

Corrective action could include:

* checking the water at a number of points
* checking the source water
* advising the water supply authority
* a check of the plumbing for dead ends, rusty pipes leaks and other sources of cross contamination
* a check of the anti-back siphonage devices
* super chlorination of the incoming supply. This is useful in eliminating a build-up of organisms in older plumbing
* retest of water.

All findings should be documented.

What is root cause analysis?

Root cause analysis can be used in the meat industry is a process used to identify and understand the initiating causes of a problem. The aim of using this process is to determine the control method that is not being implemented and so the issue/non-compliance will continue to happen.

There are three types of root causes:

* **Physical causes** which are associated with a failure in a piece of equipment or resource such as a hot water steriliser not working or incoming animals having gross contamination on their hides
* **Human Causes** are associated with workers not following a procedure be it a work instruction or a SOP. This may be caused a lack of training or a lack of supervision and feedback
* **Organisational Causes** such as workers being trained using an incorrect work instruction or the work instruction/SOP is not clear or not designed to achieve the required outcome.

This root cause analysis usually employs five steps:

**Step 1.** Identify and define the issue such as physical or microbial contamination or out of specification product being packed and delivered to a customer. This step needs to result in a precise definition of the problem

**Step 2.** Gather data relating to the issue and identify when the problem occurs and to what extent.

**Step. 3.** Identify the potential causes of the problem.

**Step 4.** Determine the root cause(s) by identifying the root cause of each of the causal factors. There are a number of ways of doing this including:

* Pareto analysis
* Five whys
* Fault tree
* Cause and effect

There are a number of resources online that can be used to explore these methods. The Five Whys: This is a problem-solving strategy that consists of asking “Why did this problem happen?” and then following the answer up with a series of additional “But why?” questions until you get to the root cause of the problem.

Why do we use Personal Protective Equipment (PPE)?

The Personal Protective Equipment (PPE) issued to employees working in a meat works is designed and used for the following reasons:

* protection for yourself
* protection for the product.

Each piece of PPE that is issued must be worn, used, cleaned and stored in a particular way to help reduce the risk of contaminating the product.

These procedures for the use of PPE are based on the requirements of the ***AS4696:2007 Australian Standard for the Hygienic Production of Meat for Human Consumption***. Export works also must follow the ***Export Meat Orders*** and importing country requirements.

|  |
| --- |
| Picture 049 |
| **A range of PPE equipment used on slaughter floors and in boning rooms**  *Photo courtesy Hepworth’s Industrial Wear Pty Ltd* |

What items of PPE do you have to wear at work and why do you need to use them?

Uniform shirts and trousers

In processing areas, a clean, light coloured uniform – usually white – must be worn each day. The reason the uniform is light coloured is to show up any dirt and blood. The uniform must be laundered every day to make sure that bacteria does not have time to multiply. If uniforms become grossly contaminated during the day they must be changed to protect you and the product from contamination.

Uniforms are also worn to protect the product from the bacteria on your body. Uniforms are also used to cover over personal clothing such as underwear or outer clothing such as jumpers. This clothing must be fully covered by the uniform.

Used uniforms must be put in the correct chutes or laundry bins to stop the spread of contamination around the premises.

You must not wear dirty clothing or uniforms into areas where edible product is being processed.

Stockmen and maintenance personnel must change before coming onto the meat processing area.

Workers who go into areas such as rendering plants or hide sheds must change into clean uniform before going into the boning room or slaughter floor.

Uniforms must not be worn off the premises.

You should avoid contaminating your uniforms during breaks. For instance don’t sit on the grass or steps.

Uniforms for freezers and chillers

Working in cold environments presents specific problems and issues. Your company WHS policy will set out when and where specific PPE for working in freezers and chillers is to be worn.

|  |
| --- |
|  |
| **PPE for freezers**  *Courtesy Fletcher International © MINTRAC* |

Head covering

Head coverings must completely cover the head and ears so hair and loose skin cannot contaminate the product. Head coverings are made of light coloured cloth or disposable material and are washed or disposed of daily. Your workplace requirements will let you know what is allowed in your plant. Disposable hats must be thrown in the correct bins at the end of each day or when they are badly contaminated.

|  |
| --- |
|  |
| **Disposable hair net**  *Photo courtesy Hepworth’s Industrial Wear Pty Ltd* |

Bump hats may be required in some production areas while hard hats are required in other production areas such as load out. They are safety requirements. Safety signs show where these hats must be worn. These hats need to be kept clean and replaced if they become chipped or cracked.

Snoods

Snoods are used to cover beards. Beards are required to be covered in all export works and many domestic premises. Snoods are disposable and must be thrown in the correct bin at the end of each day or when they are badly contaminated.

|  |
| --- |
|  |
| **Snood**  *Photo courtesy Hepworth’s Industrial Wear Pty Ltd* |

Boots

Rubber boots are designed to protect your feet from the water, blood and waste that is found on the processing floor.

|  |
| --- |
|  |
| **Rubber boots**  *Photo courtesy Hepworth’s Industrial Wear Pty Ltd* |

In some areas such as rendering plants safety boots must be worn to protect feet.

Boots need to be clean and free from contamination when you enter the processing area. This prevents soil, grease and bacteria on your boots being brought into the edible product.

|  |
| --- |
|  |
| **Boots can become heavily soiled**  *© Fletcher International* |

Boots must also be cleaned before leaving the processing area. This stops fat, blood and meat being spread all around the premises. Fat and meat on walkways and steps can make them slippery and dangerous. Leaving fat in the treads of your boots can cause you to slip and fall. For this reason, boots are washed before entering and after leaving processing areas especially boning rooms.

Fat and meat scraps also attract rats, birds and flies and are a food source for bacteria.

Plastic aprons

Aprons are used to help avoid heavy contamination from blood, meat and guts.

Disposable aprons must be changed at breaks. Heavy duty plastic aprons must be washed thoroughly when indicated by your work instructions, and at breaks.

|  |
| --- |
|  |
| **Heavy duty plastic aprons**  *Photo courtesy Hepworth’s Industrial Wear Pty Ltd* |

|  |
| --- |
|  |
| **Disposable plastic apron over mesh apron**  *© Fletcher International* |

Protective gloves and aprons

In many meat processing premises in Australia it is compulsory for people working with knives to wear protective gloves.

There are two types of protective gloves worn in production areas.

Cut resistant gloves

These gloves are made of a synthetic fibre often Kevlar. Their use has greatly reduced the incidence of knife cuts in the industry. Gloves must be laundered every day. They should be replaced if they become torn, frayed or heavily contaminated during the day’s work. A torn or frayed glove is both a hygiene hazard and a WHS hazard.

|  |
| --- |
|  |
| **Cut resistant glove**  *Photo courtesy Hepworth’s Industrial Wear Pty Ltd* |

Mesh glove

These gloves made of steel mesh come in varying lengths and for both right and left handers. They must be washed and sterilised according to the SOP and work instruction which will vary from work area to work area and task to task.

Mesh gloves must be checked for wear especially between the fingers and replaced when damaged.

|  |
| --- |
|  |
| **Mesh gloves**  *Photo courtesy Hepworth’s Industrial Wear Pty Ltd* |

In addition, insulated gloves may be required to be worn in load out, chillers and freezers.

|  |
| --- |
|  |
| **Insulated glove**  *© Fletcher international* |

Rubber or PVC gloves are used in some premises to keep protective gloves free from contamination and allow for easy washing during processing. The SOP and work instruction will explain when and how these gloves are to be worn. All damaged gloves must be replaced to prevent hygiene to the product and WHS hazards.

Protective mesh aprons protect the chest, stomach and genitals from knife cuts that can occur on the production chain.

|  |
| --- |
|  |
| **Mesh apron**  *Photo courtesy Hepworth’s Industrial Wear Pty Ltd* |

Ear plugs and ear muff covers

You must always use hearing protection in the designated hearing protection areas. Hearing protection should be worn in noisy areas.

Disposable ear plugs should be kept clean and should be disposed of at the end of each day to avoid the risk of introducing ear infections. Earmuff covers should be washed or cleaned according to work instructions.

|  |  |
| --- | --- |
|  |  |
| **Bump cap and disposable ear plugs**  *Photo courtesy Hepworth’s Industrial Wear Pty Ltd* | |

Arm and wrist guards

Arm and wrist guards protect the arms and wrists from knife cuts. The guards accumulate blood, fat and meat products which provide a good environment for bacteria to multiply. Arm and wrist guards should be cleaned at breaks and at the end of the day or shift. They should be dried thoroughly and stored in a clean area.

Belts

Slaughter floor staff are required to wear either plastic chain belts or metal chain belts with a safety link in the belt. This is to ensure that if the belt becomes caught in moving machinery it comes off easily.

In some premises supportive back belts are issued to workers in load out areas where they are continuously lifting carton meat.

|  |
| --- |
|  |
| **Back belt**  *© Fletcher International* |

Knives, scabbards and steels

The maintenance, cleaning and sterilising of the equipment is covered in the training materials for *AMPWHS201 - Sharpen and handle knives safely.*

|  |
| --- |
| IMG_2654 |
| **Knives, scabbard, steel and plastic safety chain**  *© MINTRAC* |

How is PPE to be cleaned and sanitised?

Cleaning is when dirt, dust, blood, fat and meat scraps are removed from protective equipment.

Sanitising is the way the bacterium on equipment is killed. Sanitising can be done with either chemicals and/or very hot water (82˚C+).

|  |
| --- |
| IMG_2653 |
| **Equipment being sanitised**  *Courtesy Fletcher International © MINTRAC* |

Uniforms

Employees must commence work each day with clean clothes. Most meat processing premises launder employee's clothes to ensure they are clean and sanitary. Dirty uniforms must be kept away from clean clothing.

Dirty uniforms and equipment must never be stored in lockers.

In general workers must avoid places and activities that will cause uniforms to cross contaminate edible meat products.

Aprons, gloves, knives, pouches, steels and arm guards

Aprons, gloves, knives, pouches, steels and arm guards must be cleaned and sanitised in accordance with your workplace procedures. However the general rule is that your equipment must be clean to start work, cleaned and sterilised when it becomes contaminated during processing, clean to start work after the breaks then cleaned and sanitised at the end of the day and stored in a dry area.

Mesh gloves and cut resistant gloves collect meat, fat and blood in the steel mesh or fabric. Gloves must be cleaned and sanitised regularly to reduce the bacteria that can contaminate them. Cleaning should be done in accordance with the workplace procedures and is usually done at breaks and at the end of the day or shift.

It is important to dry mesh or cut resistant gloves thoroughly and store them in a clean area. This is so bacteria do not get a chance to multiply in the moisture that accumulates in the weave of the material.

Aprons must be washed thoroughly at the end of the day and when indicated by your work instruction or task description. Aprons must be hung up to dry in a clean area once they are thoroughly cleaned.

Boots

Boots must be thoroughly washed before entering and leaving an edible product processing area like a boning room, slaughter floor or offal room. Special attention must be given to the treads on the soles of boots to ensure they are free from fat, blood and meat scraps.

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| Thoroughly cleaning the tread on boots MTMMP1B |
| **Thoroughly cleaning the tread on boots**  *© Fletcher International* |

How is PPE stored during breaks?

If you leave the processing area during breaks like morning tea or lunch, aprons, gloves, knives, steels and pouches must be cleaned and stored according to workplace procedures. They must not be left lying around, particularly in boning rooms.

|  |
| --- |
| PPE stored during a break MTMMP1B |
| **PPE stored during a break**  *© Fletcher international* |

How is PPE stored at the end of the day?

At the end of the day or shift all personal equipment must be stored according to the work instructions for your premises. Lockers must be kept clean to ensure they don't harbour bacteria or provide food for pests. Street clothes must be stored in a locker when not in use. To prevent contamination of street clothes to work clothes and visa versa, follow workplace procedures. These usually involve one of the following instructions:

do not store work clothes in locker

never have street clothes in the same locker with personal equipment

only store clean dry equipment in your locker.

|  |
| --- |
| A tidy locker MTMMP1B |
| **A tidy locker**  *© Fletcher International* |

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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.

Attachment One

Conduct statistical analysis of process

Collect and analyse workplace statistical data

What is the purpose of statistical analysis?

Sometimes the word ‘statistics’ can create concern for people, and yet we are exposed to statistics every day. The most obvious example of everyday statistics is when you look at Monday’s newspapers to check the success of your favorite team. The newspaper will normally give you all sorts of statistics.

Statistics can be used as quantitative tools for quality control. However, they will be more effective if the people actually **producing** the goods and services also have the responsibility for **applying** these tools.

Access to computers with appropriate software has made many methods, which previously required complicated calculations, more readily available. This advance has meant that using statistics may no longer be the primary responsibility of your quality department, but may be the responsibility of the line workforce.

In the meat industry, statistical analysis can be used in the development of systems and procedures to monitor and control the production of quality, safe meat.

Using statistical analysis a meat processor can for example:

* monitor a process to ensure conformance with legislative requirements and workplace specifications
* identify trends in the process and/or the product as part of a Quality Assurance continuous improvement program.

The major aim of statistical analysis in the meat industry is to monitor and reduce, or control, the amount of **variation** that can occur at any stage of the process by collecting data that describes the process and then presenting the data in a way that is easy to interpret and take any appropriate corrective action.

What is variation and what are the causes of variation?

Variation is common to life. Very rarely in manufacturing, if ever, are two things exactly alike. This is why manufacturers include tolerances of variation in product specifications.

Statistical analysis is used to:

* measure the amount of variation
* monitor process output
* determine process capability
* develop and implement process improvement plans.

There are two causes of variation:

* common causes
* special causes.

Common causes occur as part of the process and will continue to occur unless the process or system is improved. For example, low yields may be due to a common cause such as poor work instructions, inadequate training, poor quality raw materials, lack of communication or poor work conditions.

Special causes can be traced back to a particular event or circumstance and can usually be fixed without changing the process or system. For example, a machine breakdown or power failure.

If all special causes of variation are removed so that the only variation occurring is the result of common causes, a process is described as being stable or in control.

The first step in conducting a statistical analysis of a process is to collect the appropriate workplace data.

What are the basic types of workplace data?

There are two basic types of numerical workplace data collected in the meat processing industry:

* attribute data
* variable data.

Attribute (or discrete) data refers to things that can be counted – for example, the presence of a required label, the number of damaged packets in a batch, the number of rejects.

Variable (or continuous) data refers to data collected from measuring something – for example, the weight or temperature.

The way you collect and analyse data depends on the type of data you are dealing with. **Check sheets** are usually used to collect attribute data. **Process control charts** are usually used to record variable data.

What are the rules for collecting data?

John McConnell, in *Seven Tools of TQC*, has identified the four ‘Rs’ for data collection:

|  |  |
| --- | --- |
| Data must be **R**elevant | The data must tell us what we need to know.  We must be sure that the data we are gathering is appropriate for the purpose. We must be sure that the data will give us the full picture. |
| Data must be **R**eliable | The methods and measuring devices must be appropriate and accurate.  The people gathering the data must be well trained and motivated. |
| Data must be **R**epresentative | The data must be collected in such a way that it is representative of the entire batch, or lot, from which it was taken.  The frequency of sampling must be capable of presenting an accurate picture of the items you did not sample. |
| Data must be **R**eadable | Data must be collected so that anyone can read it accurately and without difficulty.  Data collected should be presented in such a way as to ensure it is easily understood, e.g. where it came from. |

In general, the people involved in the process should collect the workplace data, and they should have a clear understanding of why the data is being collected and how the data will be used.

What are the main uses of data?

*The Seven Tools of TQC*, states that data has three main uses:

* process analysis
* process improvement and control
* acceptance or rejection.

Data for process analysis

This is used to analyse the outcomes of a process to determine:

* how it currently operates
* its outcomes
* the variation and the effect of this variation on quality.

Data collected for process analysis may be either variable data or attribute data.

Data for process improvement and control

This is used to improve the process and to confirm the outcomes of the improvement strategies. This data is also used to monitor the process, so that any change to outcomes is detected and corrective action can be taken.

Data collected for process improvement and control may be either variable data or attribute data.

Data for acceptance and/or rejection

Thisis used to decide whether to accept or reject a lot or batches from a supplier, or to determine if goods produced by you are fit for sale. Data for this purpose is normally collected by total inspection or by following an appropriate sampling plan.

What is total inspection?

Total (or 100%) inspection requires each item produced to be inspected. 100% inspection is not practical in most cases and does not guarantee that all materials will be free from defects.

Post mortem inspection is total inspection.

What is sampling?

Sampling is a process for selecting items to measure as part of a quality management system. Sampling is required because it is usually impractical or uneconomical to measure every item being manufactured. The normal practice is to select a sample, measure it, and make a decision based on that data.

Sampling inspection(also called ‘acceptance sampling’) uses statistical methods to assess whole populations; it enables the qualities of an entire production lot to be established, based on the quality of a sample. Sampling inspection uses *Australian Standard AS 1199-2003* as the basic guide. This standard is based on batch production but can be adapted for use with continuous production.

Key elements of sampling inspection are the sample size and the number accepted.

The most important thing about sampling is to ensure that the sample you have selected is **representative** of the entire group, or population.

What is a representative sample?

It is important to remember that when taking samples for testing, the sample must be taken in such a way as to ensure that:

* it represents the entire lot or batch from which it was taken – the fate of the entire lot is often in question, particularly with regard to microbiological testing
* the nature of the sample, or the batch from which its taken is not changed in any way during the sampling, or subsequent handling and testing.

The way the results of tests and inspections are recorded, i.e. how workplace data is collected, depends on the type of data collected. The workplace data collected may be either attribute data or variable data.

How is workplace data collected?

To ensure we get good, meaningful data, we need to collect it in such a way that the chance of error is as low as possible. Therefore, planning on how we are going to collect our data is as important as deciding on what data to collect.

An **attribute** is a characteristic that is appraised in terms of whether it does or doesn’t exist with respect to a given requirement. The simplest way to collect attribute data is by using check sheets.

A **variable** is a characteristic that is appraised in terms of values on a continuous scale. Variable data may be collected using charts, such as run charts, frequency histograms, or process control charts.

Check sheets

Check sheets can be used for a great number of functions, from recording where process defects occur, to the number of times a defect occurs in a product. To ensure your check sheets are useful, you should address the following points.

* Are you clear on what you are trying to do with the check sheets?
* How are you going to confirm the effectiveness of the check sheet?
* What are you going to do with the information obtained?
* Have you got enough information on your check sheet to identify:
  + the process?
  + time?
  + location?
  + who collected the data?

Check sheets come in a variety of different types. Their design and use will depend on your organisation’s procedures and the situation they are being used for.

***Confirmation check sheet***  
  
The simplest is a sheet, which you simply tick to confirm you have checked a particular item.

|  |  |  |
| --- | --- | --- |
| Item | Pallet Jack Operational Check | |
| OK | Not OK |
| Horn |  |  |
| Raise forks |  |  |
| Lower forks |  |  |
| Brakes |  |  |
| Steering |  |  |
| Mast tilt |  |  |
| Fork tip |  |  |

Defect check sheet

These sheets are used to record the number of defects in a production run. Defects to be checked are decided upon in advance and each defect is recorded. Some items may have more than one defect. If this factor is to be recorded, it may be necessary to add an additional column to your check sheet.

|  |  |  |
| --- | --- | --- |
| Defect | Occurrence | Total |
| Clip missing | ~~| | | | | | | | | | | | | |~~ | | | | | 18 |
| Split casing | ~~| | | | | | | | | |~~ | | | 12 |
| No use-by date | ~~| | | | ||~~ | | | | | 9 |
| Air bubbles | ~~| | | | | | | | | |~~ | | 11 |
| Holes in casing | ~~| | | | |~~ | | | | 8 |
| Warped shape | | | | | | 4 |

What statistical calculations are used in meat processing?

Statistical calculations can be used to demonstrate conformance to specification and legal requirements. They can include:

* yield
* mean (or average)
* median
* mode
* range.

Determining the **yield** is a common statistical analysis applied to meat processing. It is typically used to calculate the yield of meat boned from carcases and recovery of co-products (e.g. offal, hides, etc).

The **mean**, **median** and **mode** are the three key measurements for determining the *accuracy* of a process. Accuracy describes how well the process is ‘aimed’ at the desired outcome.

The **range** is the simplest way of measuring **precision**. This describes how consistently the process is or isn't meeting its aim. In general, precision problems are a lot harder to fix than accuracy problems.

How is the yield of a process calculated?

To calculate the yield, we compare the input (or theoretical yield) with the output (actual yield) and convert to a percentage:

% Yield = actual yield x 100%

theoretical yield

For example, suppose a process of packaging a spice mix involves repacking a 25kg mix into 150g sachets and the process allows up to +1.5g per sachet. The theoretical yield would be 165 sachets per 25kg mix.

If a count of the number of sachets packaged per 25kg mix was found to be 142 sachets, the yield would be calculated as follows:

% Yield = 142 x 100%

165

= 86%

How are the mean, median and mode calculated?

Probably the most widely used and most generally understood way of describing the central tendency, or central location, of a set of data is the average, commonly known as the arithmetic **mean***.* The arithmetic mean, or simply the mean, is the total of the values of a set of observations divided by their number.

For example, the following table represents the recorded weights (in kg) of sides of beef:

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Sample weight | 125kg | 130kg | 135kg | 140kg | 145kg | 150kg | 155kg | 160kg | 165kg | 170kg | 175kg |

Total weight of all samples:

125+130+135+140+145+150+155+160+165+170+175 = 1650

Total number of samples: = 11

Mean (average): 1650 ÷ 11 = 150

Mean of the samples = 150 kg

The **median** is another well-known and widely used average. It is known as the ‘middlemost’ or most central value of a set of numbers, i.e. half of the values are above it and the other half are below it. In our case the median would be 150kg.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample weight | 125kg | 130kg | 135kg | 140kg | 145kg | 150kg | 155kg | 160kg | 165kg | 170kg | 175kg |

Values range from 125 to 175

Number of samples = 11

Median: (middle sample) = 150

Median: = 150 kg

The simplest value to work out is the mode. The mode is the measurement that occurs most often, i.e. the value with the highest frequency. To find the mode easily a frequency table or histogram is used. In the example we have used we can’t work out the mode because we have insufficient data.

How is the range calculated?

Checking precision involves measuring the spread, the dispersion, the variability and the consistency.

The simplest measure of dispersion is called the range. This is the difference between the highest and the lowest value measured. For example:

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Sample weight | 125kg | 130kg | 135kg | 140kg | 145kg | 150kg | 155kg | 160kg | 165kg | 170kg | 175kg |

In the case of the sides of beef, the range is 175 - 125 = 50.

One disadvantage of the range is that it only uses two of the values, ignoring the potentially valuable information contained in the rest. Another problem is that it only takes one unusually high or low value to distort the range and make the dispersion look bigger than it really is.

How is data presented?

Data is just numbers, or sometimes words or marks. It isn't really useful, that is, it isn't really information until it tells us something meaningful about our processes.

There are a number of ways by which we can present data to allow us to understand what is happening with our processes. This may involve the use of the following instruments:

* run charts and graphs
* histograms
* process control charts.

The way data is presented depends on the purpose of the statistical analysis.

What are run charts and how are they prepared?

If we were investigating a process where we make bags of spices of 150 grams, a key performance measure would be the **actual** weight of the bags as they come off the filling line.

Suppose we have introduced a systematic process for sampling that consisted of weighing one bag every 15 minutes. After weighing our fifty bags, we could have data like the following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sample # | Weight (grams) |  | Sample # | Weight (grams) |
| 1 | 157 |  | 26 | 157 |
| 2 | 152 |  | 27 | 156 |
| 3 | 160 |  | 28 | 149 |
| 4 | 151 |  | 29 | 159 |
| 5 | 159 |  | 30 | 162 |
| 6 | 156 |  | 31 | 157 |
| 7 | 158 |  | 32 | 163 |
| 8 | 155 |  | 33 | 156 |
| 9 | 159 |  | 34 | 158 |
| 10 | 159 |  | 35 | 157 |
| 11 | 150 |  | 36 | 155 |
| 12 | 154 |  | 37 | 161 |
| 13 | 155 |  | 38 | 153 |
| 14 | 158 |  | 39 | 161 |
| 15 | 154 |  | 40 | 157 |
| 16 | 157 |  | 41 | 154 |
| 16 | 157 |  | 42 | 155 |
| 18 | 152 |  | 43 | 154 |
| 19 | 150 |  | 44 | 156 |
| 20 | 154 |  | 45 | 160 |
| 21 | 158 |  | 46 | 157 |
| 22 | 158 |  | 47 | 155 |
| 23 | 156 |  | 48 | 158 |
| 24 | 160 |  | 49 | 151 |
| 25 | 153 |  | 50 | 156 |

Just looking at these numbers tells us very little about our process. The two things we are investigating are:

* on average, does the process actually make bags of 150 grams?
* how much does the weight of each bag vary from 150 grams?

To find this out we need to use arun chart*.*

A run chart is a simple graph that shows how the value of a measurement *varies* over a period of time. If we plot the data from our table on page 13, we can quickly get a visual impression.

There are usually no specifications on the chart, which is one of the limitations of using run charts as opposed to process control charts*.*

Data, such as presented in the table above, can be plotted to see if there are any obvious trends occurring or developing over time.

While the run chart above shows that there is a lot of variation across the samples tested, it also shows that we are overfilling almost every bag. The overfilling is because of the variation in the process. If we did not overfill, we would get too many under filled bags.

Therefore, if we could reduce the variation in fill, we could reduce costs and save some money.

The run chart also shows that while there is a lot of variation, the process looks fairly stable. This is because it doesn't seem to be trending upwards or downwards. Also, there doesn't seem to be any points that are way out on their own and don't belong. This indicates to us that the process is in control and that the variation is due to common causes.

What are histograms and how are they prepared?

Histograms are used to tell us about the aim of the process and also to indicate the variation in the process.

In simple words, histograms are data that is presented as a graph. Histograms will only be relevant if the data on which they are based comes from the same, steady, unchanging process. That is, the process exhibits no variation due to special causes – the process is stable.

A histogram is prepared by grouping the data. This is normally done through tally or check sheet when we are collecting our data.

For example, if we drew up a process distribution check sheet from the data concerning the filled weight of our bags of product, we would write down the various values we have observed. Then we would count how many times each value occurred in our set of fiftymeasurements. The number of times a value occurs is called its **frequency**.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Weight** | **Tally** | **Number** |  | **Weight** | **Tally** | **Number** |
| 149 | | | 1 |  | 157 | ~~| | | | |~~ | | | 7 |
| 150 | | | 1 |  | 158 | ~~| | | | |~~ | | 6 |
| 151 | | | | 2 |  | 159 | | | | | | 4 |
| 152 | | | | | 3 |  | 160 | | | | | 3 |
| 153 | | | | | 3 |  | 161 | | | | 2 |
| 154 | ~~| | | | |~~ | 5 |  | 162 | | | 1 |
| 155 | ~~| | | | |~~ | 5 |  | 163 | | | 1 |
| 156 | ~~| | | | |~~ | | 6 |  |  |  |  |

We now assemble our measurements by plotting them on a horizontal scale. To help with explaining the process, we will look at each measurement separately. If the first sample collected weighed 157 grams, it would be plotted as below:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Scale | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
|  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
|  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
| 149 | | 150 | | 151 | | 152 | | 153 | | 154 | | 155 | | 156 | | 157 | | 158 | | 159 | | 160 | | 161 | | 162 | | 163 | |

**Weight (grams)**

The next piece of data is then plotted. This process continues until all data is plotted. Any variation will become evident as each additional data is added.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Scale | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
|  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
|  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
| 149 | | 150 | | 151 | | 152 | | 153 | | 154 | | 155 | | 156 | | 157 | | 158 | | 159 | | 160 | | 161 | | 162 | | 163 | |

**Weight (grams)**

As can be seen, variation is already evident. As each additional piece of data is added, a shape will become obvious.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Scale | |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 |

**Weight (grams)**

In a histogram the boxes are joined to create bars. The following histogram was drawn by plotting weights of each unit along the base (x) axis, and the frequency (the number of times each weight was recorded) is shown on the vertical (y) axis.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 8 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 7 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 6 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 |

**Weight (grams)**

As can be seen, the histogram paints a very different picture of our process. The most obvious feature is that the time sequence of our measurements is not included. This is why we prepared a run chart before the histogram to confirm that our process was stable or in-control.

This histogram gives us some valuable information about both the accuracy and the precision of our process.

Accuracy

This describes how well the process is ‘aimed’ at the desired outcome. This histogram's shape suggests that the process is more or less aimed at round about 157 grams, i.e. the bags are consistently being overfilled.

Precision

This describes how consistently the process is or isn't meeting its aim. Again our histogram shows that there is wide variation about the average. Even in a sample of fifty, we got weights as low as 149 grams, and as high as 163 grams.

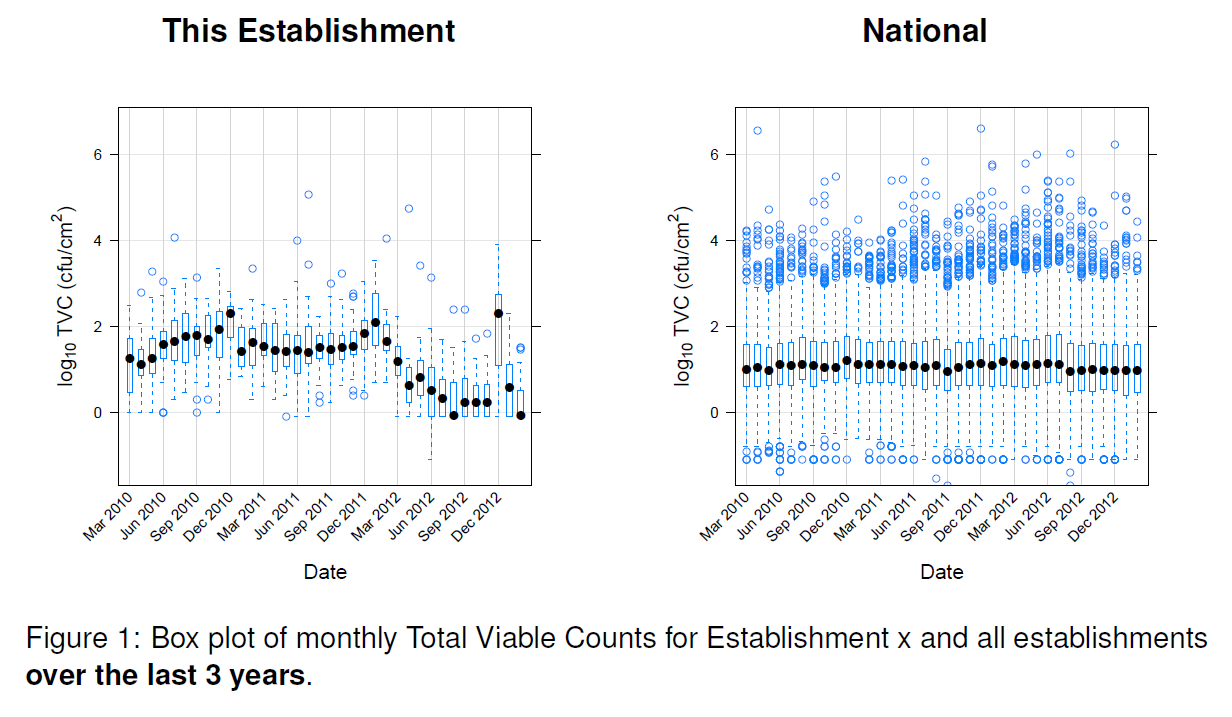
What are box plots and how are they presented?

A box plot or box plot is a convenient way of graphically depicting groups of numerical data through their quartiles. Box plots may also have lines extending vertically from the boxes (whiskers) indicating variability outside the upper and lower quartiles, hence the terms box-and-whisker plot and box-and-whisker diagram. Outliers may be plotted as individual points.

Box plots display variation in samples of a statistical population without making any assumptions of the underlying statistical distribution. The spacings between the different parts of the box indicate the degree of dispersion (spread) and skewness in the data, and show outliers. In addition to the points themselves, they allow one to visually estimate various L-estimators, notably the interquartile range, midhinge, range, mid-range, and trimean. Boxplots can be drawn either horizontally or vertically.

Box and whisker plots are uniform in their use of the box: the bottom and top of the box are always the first and third quartiles, and the band inside the box is always the second quartile (the median).

Below is an example of a box plot presented by MLA at Meat Inspector and Quality Assurance meetings, to provide a comparison of TVCs for a single establishment against national data.



© MLA

More information on the use of box plots for interpreting ESAM data can be found in Attachment 1: Explanatory Guide for the E. coli and Salmonella Monitoring (ESAM) Reports.

What is a process control chart?

Process control charts are tools that allow meat processors to monitor the variation that occurs in the process. This is done by looking at the:

* time frame in which the product is made
* nature of variability in the system.

Data presented in a process control chart is typically used as the foundation of improving processes.

Process control charts are used to evaluate:

* performance over time
* opportunities for improvement
* trends which may result in non-conformances.

Process control charts also provide an opportunity to determine the cause of variation*.* That is, is it from common causes or it is the result of a special cause, which may indicate problems to be fixed?

Using a process control chart

There are a number of fundamental points to consider when using process control charts. They include:

* average and range control charts only apply to variable data (measured) and not attribute data (counted)
* upper control limits (UCL) and lower control limits (LCL) are used to determine if the process is in control
* if our data points are located inside the upper and lower control limits then the variation is due to random or common causes. Adjusting the process corrects random or common cause variation
* if our data points are located outside the upper and lower control limits then the variation is due to special causes. Special cause variations are corrected by applying a problem-solving model to correct the special cause
* if our data points are located inside the upper and lower control limits then our process is said to be ‘in control’
* if our data points are located outside the upper and lower control limits then our process is considered to be ‘out of control’
* basic calculations are required to develop an average and range control chart.

An and R chart consists of three main parts.

The upper graph is called an X-bar chart, because an X with a bar over the top is the mathematical symbol for the average of a sample. It essentially tracks the aim of the process.

The middle picture is an R chart, because R is the symbol for the range of a sample. The range is simply the difference between the highest and lowest measurement in the sample. By similar methods as used for the average chart, it is possible to calculate an average and upper and lower control limits for the sample range.

The table at the bottom of the chart contains the data from which the points are plotted. In each column there are seven numbers. The top five are the weights of the five samples. The two numbers below the samples are the average weight and the range.

How is data collected for and R charts?[[1]](#footnote-1)

The use of control charts simplifies process control. Instead of taking enough samples to build a histogram every hour we take (say) five samples per hour, and calculate the average () and range (R) of the samples. Once you have twenty or so averages you can construct an and R chart. (The frequency of your sampling will depend on the number of units your process makes per hour/day).

To ensure accuracy of our  and R charts:

* data should be collected on suitable data sheets
* data should be collected in sub-groups of at least four units/samples
* samples should all be drawn from the same batch, lot, or shift
* only sub-groups of samples that occurred under the same operating conditions are used.

How do you calculate the average () and range (R) of data?

For each sub-group of data you will have to calculate:

* average
* range.

To calculate the average, you simply add up all of the values in the sub-group and divide them by the number of values in the sub-group.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Date | Hour | Sample weight | | | | | Average | Range |
| Sample 1 | Sample 2 | Sample 3 | Sample 4 | Sample 5 |
| March 8 | 9.00 | 200 | 220 | 190 | 195 | 205 | 202 | ? |
|  | 10.00 | 205 | 225 | 225 | 230 | 215 | ? | ? |
|  | 12.00 | 200 | 205 | 230 | 220 | 215 | ? | ? |
|  | 2.00 | 210 | 220 | 220 | 230 | 220 | ? | ? |
|  | 4.00 | 225 | 195 | 225 | 220 | 210 | ? | ? |

To calculate the average () of a group of numbers:

 = 

 = 202

To calculate the range (R) you simply take away the smallest value from the largest value in the sample results in the sub-group.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Date | Hour | Sample weight | | | | | Average | Range |
| Sample 1 | Sample 2 | Sample 3 | Sample 4 | Sample 5 |
| March 8 | 9.00 | 200 | 220 | 190 | 195 | 205 | ? | 30 |
|  | 10.00 | 205 | 225 | 225 | 230 | 215 | ? | ? |
|  | 12.00 | 200 | 205 | 230 | 220 | 215 | ? | ? |
|  | 2.00 | 210 | 220 | 220 | 230 | 220 | ? | ? |
|  | 4.00 | 225 | 195 | 225 | 220 | 210 | ? | ? |

To calculate the range:

R = 220 – 190

R = 30

How do you calculate the average of the averages () and the average of the ranges ()

We will use the following data sheet for the data to calculate our and values.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Date | Hour | Sample weight | | | | | Average | Range |
| Sample 1 | Sample 2 | Sample 3 | Sample 4 | Sample 5 |
| March 8 | 9.00 | 200 | 220 | 190 | 195 | 205 | 202 | 30 |
|  | 10.00 | 205 | 225 | 225 | 230 | 215 | 220 | 25 |
|  | 12.00 | 200 | 205 | 230 | 220 | 215 | 214 | 30 |
|  | 2.00 | 210 | 220 | 220 | 230 | 220 | 220 | 20 |
|  | 4.00 | 225 | 195 | 225 | 220 | 210 | 215 | 30 |
| March 9 | 9.00 | 230 | 235 | 210 | 220 | 200 | 219 | 35 |
|  | 11.00 | 190 | 200 | 220 | 205 | 225 | 208 | 35 |
|  | 12.00 | 215 | 205 | 190 | 195 | 195 | 200 | 25 |
|  | 2.00 | 210 | 225 | 200 | 220 | 220 | 215 | 25 |
|  | 4.00 | 215 | 230 | 220 | 230 | 185 | 216 | 45 |
| March 10 | 8.00 | 200 | 195 | 210 | 210 | 205 | 202 | 15 |
|  | 11.00 | 190 | 210 | 210 | 210 | 205 | 205 | 20 |
|  | 12.00 | 195 | 205 | 210 | 205 | 210 | 205 | 15 |
|  | 2.00 | 200 | 215 | 240 | 230 | 200 | 217 | 40 |
|  | 4.00 | 225 | 195 | 210 | 215 | 210 | 211 | 30 |
| March 11 | 8.00 | 215 | 205 | 220 | 215 | 235 | 218 | 30 |
|  | 10.00 | 190 | 215 | 230 | 210 | 235 | 216 | 45 |
|  | 12.00 | 210 | 205 | 195 | 220 | 210 | 208 | 25 |
|  | 2.00 | 200 | 235 | 240 | 205 | 215 | 219 | 40 |
|  | 4.00 | 220 | 205 | 210 | 225 | 200 | 212 | 25 |
| March 12 | 8.00 | 190 | 205 | 210 | 205 | 225 | 207 | 35 |
|  | 10.00 | 215 | 250 | 210 | 160 | 210 | 215 | 60 |
|  | 12.00 | 170 | 200 | 180 | 200 | 190 | 188 | 30 |
|  | 2.00 | 225 | 220 | 220 | 195 | 205 | 213 | 30 |
|  | 5.00 | 185 | 220 | 225 | *210* | 215 | 211 | 40 |
| Totals |  |  |  |  |  |  | 5276 | 780 |

To get the average of the averages () you:

* simply add up the averages of the sample sub-groups
* divide the total by the number of sub-groups e.g.

  = 211.04 (round off to nearest number)

**** **= 211**

To calculate  we add up all the ranges of each sub-group and, once again, divided it by the number of ranges e.g.

  = 31.2 (round off to nearest number)

** = 31**

Using averages and ranges

Ten cartons of boneless beef were weighed as follows:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Weight (kg) | | | | | | | | | |
| 20.1 | 20.2 | 20.1 | 20.3 | 20.3 | 20.2 | 20.1 | 20.3 | 20.2 | 20.2 |

The mean or average weight is calculated as:

202 kg ÷ 10 = 20.2 kg

The range is calculated as:

20.1 – 20.3 kg

The average of grams ‘wastage’ per carton is 200 grams.

The average daily wastage (in kg), assuming that 2000 cartons are packed per day is 400 kg.

How do you calculate the upper and lower control limits for the average and range charts?

To calculate the control limits for our control charts we are required to use some coefficient tables that were derived from a statistical model by mathematicians. The table below is an extract only. Your company will either have these tables or have a computer program that will calculate your data to produce process control charts for you.

|  |  |  |  |
| --- | --- | --- | --- |
| n | A2 | D4 | D3 |
| 4 | 0.729 | 2.282 | 0 |
| 5 | 0.577 | 2.115 | 0 |
| 6 | 0.483 | 2.004 | 0 |
| 7 | 0.419 | 1.924 | 0.076 |
| 8 | 0.373 | 1.864 | 0.136 |
| 9 | 0.337 | 1.816 | 0.184 |
| 10 | 0.308 | 1.777 | 0.223 |

Depending on which control limit you are calculating, you simply look down the ‘n’ (number of data) column until you find the number of samples in each of your sub-groups. Then, depending on the control limit you are calculating, take the corresponding number in the A2, D4 or D3 column.

Calculating control limits for the average chart

To calculate the control limits for the average chart you will need to complete the following equations:

UCL =  + A2

LCL =  - A2

The various symbols and letters used in the equation have the following meanings:

* – is the average of the averages of our sub-groups, which is 211
* A2 – as we have five samples in our sub-groups we read the value in our coefficient chart in the A2 column in the fifth row, which is 0.577
*  – is simply the average of the ranges, which is 31.

While these equations may look quite confusing, when we replace the symbols with actual numbers they become quite simple.

Calculating upper and lower control limits for the average chart

To calculate the upper and lower control limits for the average chart, you will need to complete the following equations, using the figures obtained from our data sheet.

UCL = 211 + (0.577 x 31)

**UCL = 229**

LCL = 211 – (0.577 x 31)

**LCL = 193**

The steps we use to complete our equation are to multiply the numbers in the brackets and then, depending on which control limit you are calculating, either add the total to, or take it away from, .

Calculating control limits for the range chart

To calculate the control limits for the range chart you will need to complete the following equations:

UCL = D4

LCL = D3

The various symbols and letters used have the following meanings:

* – is simply the average of the ranges, which is 31
* D3 – as we have five samples in our sub-groups we read the value in our coefficient chart in the D3 column in the fifth row, which is 0. As can be seen on our coefficient chart unless our sub-groups have more than seven pieces of data the LCL in range charts is always zero.
* D4 – as we have five samples in our sub-groups we read the value in our coefficient chart in the D4 column in the fifth row, which is 2.115

Using the figures obtained from our data sheet, our calculations for the upper and lower control limits for our ranges (R) chart:

UCL = 2.115 x 31

**UCL = 66**

LCL = 0 x 31

**LCL = 0**

The steps we use to complete our equation when calculating the upper and lower range control limits, are to simply multiply the two numbers together.

How do you complete an and R process control chart?

After we have collected our data and calculated our averages, ranges and control limits, we simply have to complete our control chart.

Remember when we plot our data on the averages graph and the ranges graph, we should immediately investigate any situations where our data is **outside** the control limits.

Adapted from McConnel J, *Seven Tools of TQC* (1992)

Use statistical analysis to verify the process

How can statistical analysis be used to verify the process?

Statistical analysis can be used to show variation over time and to put the appropriate controls in place to improve the output by reducing the variation.

The type of statistical tools will vary depending on the aspect of the process under investigation. Typically, the statistical tools used could include:

* frequency histograms
* process control charts.

What information can we get from frequency histograms?

Histograms are a form of bar graph that show the centering spread and distribution shape of a process variation.

If we look at our histogram of the sides of beef, we can see the average weight of the beef sides is 150 kilograms, while the majority of the samples are between 140 kilograms and 160 kilograms. This type of spread of results is called ‘normal distribution’, and its characteristic shape is a cross-sectional bell, as shown below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Average** | 8 |  |  |  |  |  |  |  |  |  |  |  |
|  | 7 |  |  |  |  |  |  |  |  |  |  |  |
|  | 6 |  |  |  |  |  |  |  |  |  |  |  |
|  | 5 |  |  |  |  |  |  |  |  |  |  |
|  | 4 |  |  |  |  |  |  |  |  |  |  |
|  | 3 |  |  |  |  |  |  |  |  |  |  |
|  | 2 |  |  |  |  |  |  |  |  |  |  |
|  | 1 |  |  |  |  |  |  |  |  |  |  |  |
|  | 0 |  |  |  |  |  |  |  |  |  |  |  |
|  |  | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 |

##### Weight (kilograms) of beef sides

Histogram showing a normal distribution

The following histogram shows a process with a narrow distribution. It is well centred and clearly within the specification and represents an ideal situation.

When we are confronted with a process that is not ideal, we can identify what may be wrong and what corrective action may be required, by studying the shape of our histogram.

Lower centre limit Average Upper center limit

(lcl) (ucl)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
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Process with a wide distribution

This process is well centred but has a wide distribution and therefore will be producing products that are outside the specification limits. This means the process is out of control. We can try to reduce the variation by addressing the common causes.





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A process that is off target

This histogram shows a process with a small range but the process is not centred. This means that while the process is under control (because of the small range), around the mid-point of its acceptable centre line range. However, some product is being produced outside our specification limits. We need to correct the process by correcting the special cause.



|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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Presence of special cause

This histogram shows a process result with two peaks. This indicates that there is more than one cause present. Another reason our histogram may look like this is if it has been adjusted during the sampling. You should attempt to identify and correct the special cause in such a way as to prevent it happening again.



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Incapable process

Our next example shows a process that is not centred and has too much variation. Therefore both an adjustment to the process and an effort to reduce common causes is required.



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What information can we get from process control charts?

Process control charts will reflect the *effects* of any changes that we make to the process.

Process control charts also enable us to ensure that the process remains in control. This means keeping a continuous check on outcomes and results to continually monitor the process. This task is best done by the people who actually operate the process.

Control charts, if they are properly analysed, can be very powerful tools for monitoring our processes. The following charts show some of the more common patterns that appear on control charts.

Trend of gradient rise or fall

A trend or gradual rise or fall indicates that the process is drifting. Equipment wear could cause this pattern to occur.



Points outside control limits

Points outside control limits indicate a special cause. The points circled must be investigated immediately. Do not wait for a second occurrence. Whenever possible, the reason and corrective action should be recorded on the chart.



Cycles

Cycles are when there is a consistent pattern of repeated high and low points. These cycles may be caused by rotation of operators or even temperature changes during the day.



Instability

Instability is shown by unnaturally large fluctuations which may be caused by erratic test equipment, mixed material lots or over-adjusting. Investigation is **essential**.



1.  = Mean or average; Σ = sum of; *f* = frequency; [↑](#footnote-ref-1)