2 ISSN 1810-1119

FAO ANIMAL PRODUCTION AND HEALTH

manual

GOOD PRACTICES FOR THE MEAT INDUSTRY

Fondation Internationale Carrefour

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GOOD PRACTICES FOR THE MEAT INDUSTRY

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
FONDATION INTERNATIONALE CARREFOUR
Rome, 2004

Produced by the
Editorial Production and Design Group
Publishing Management Service
FAO

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ISBN 92-5-105146-1

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Foreword

The FAO/WHO Codex Alimentarius Commission is in the final stages of negotiation of a new Code of hygienic practice for meat. The Code implies a transition from meat inspection towards a risk-based approach covering the entire food chain. The manual on good practices for the meat industry aims to assist the industry to prepare itself for compliance with the new regulatory framework, which is expected to come into force when the Code is approved in 2005.

To help facilitate this transition, the Fondation Internationale Carrefour has provided FAO with financial support in the preparation of this manual. FAO wishes to extend its thanks to the Fondation Internationale Carrefour for supporting this important step in the implementation of the new Code of Practice for an industry that is growing globally at an unprecedented rate.

This manual is targeted at the meat industry in developing countries and in emerging economies in their endeavour to meet the rising quality and safety requirements of both the export industry and domestic markets, with the increasing participation of large-scale retailers.

Section 1 of the manual deals with the application of risk analysis principles to the meat sector starting from the point of production, i.e. in the animal population from which the meat is sourced. Standards and practices in primary production are covered in Section 2. Section 3 covers animal identification and Section 4 product traceability.

The following section (5) focuses on transport of animals to the slaughter facilities, duly taking into account growing animal welfare considerations. This is followed by Sections 6, 7, 8 and 9 on ante-mortem inspection; preslaughter handling, stunning and slaughter methods; post-mortem examination; and hygiene, dressing and carcass handling. The sections on stunning and slaughter methods benefit from the experience gained in the reduction of the risk of BSE (bovine spongiform encephalopathy). Those on ante- and post-mortem inspection are built on the substantial historical experience of the global meat sector, and are largely documented from FAO resources.

There are sections on design, facilities and equipment (10) and personal hygiene (11). Section 12 of the manual describes the implementation of a Hazard Analysis and Critical Control Point (HACCP) plan for the meat industry. Finally, there is a section (13) on the role of governments and other regulatory authorities in meat hygiene.

The manual is prepared in such a way that it can be updated flexibly once the Code is adopted by the Codex Commission. An effort will also be made to incorporate feedback from the industry on the use of the manual when preparing such updates. It is hoped that the collaboration initiated between FAO and the private sector in the preparation of this manual will be extended and deepened in this process.

Rome, July 2004

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Acknowledgements

The following authors have collaborated with FAO in the production of the manual: Dr Steve Hathaway, New Zealand Food Safety Authority; Dr Roger Paskin, Meat Board of Namibia; Drs Haluk Anil, Sava Buncic, Alan Fisher, Alison Small, Paul Warriss and Steve Wotton, Division of Farm Animal Science, Department of Clinical Veterinary Science, University of Bristol, UK; and Ms Langa Simela, Zimbabwe.

Several FAO staff in the Food and Nutrition Division, Economic and Social Department, and in the Animal Production and Health Division, Agriculture Department, contributed to the technical review of the material.

Sections 6 and 8 are updated and reprinted from FAO Animal Production and Health Paper No. 119, *Manual on meat inspection for developing countries* (1994). The original publication was planned, coordinated and edited by Dr G. Heinz and Mr K. Amamoto of FAO. The principal author of this publication was Dr D. Herenda, Canada; Dr P.G. Chambers, Zimbabwe, Dr P. Seneviratna, Australia, Prof. Dr T.J. da Silva, Brazil, and Prof. Dr A. Ettriqui, Tunisia, all contributed.

CODEX ALIMENTARIUS

General principles of meat hygiene

1. Meat must be safe and suitable for human consumption and all interested parties including government, industry and consumers have a role in achieving this outcome.[1]
2. The competent authority should have the legal power to set and enforce regulatory meat hygiene requirements, and have final responsibility for verifying that regulatory meat hygiene requirements are met. It should be the responsibility of the establishment operator to produce meat that is safe and suitable in accordance with regulatory meat hygiene requirements. There should be a legal obligation on relevant parties to provide any information and assistance as may be required by the competent authority.
3. Meat hygiene programmes should have as their primary goal the protection of public health and should be based on a scientific evaluation of meat-borne risks to human health and take into account all relevant food safety hazards, as identified by research, monitoring and other relevant activities.
4. The principles of food safety risk analysis should be incorporated wherever possible and appropriate in the design and implementation of meat hygiene programmes.[2]
5. Wherever possible and practical, competent authorities should formulate food safety objectives (FSOs) according to a risk-based approach so as to objectively express the level of hazard control that is required to meet public health goals.
6. Meat hygiene requirements should control hazards to the greatest extent practicable throughout the entire food chain. Information available from primary production should be taken into account so as to tailor meat hygiene requirements to the spectrum and prevalence of hazards in the animal population from which the meat is sourced.
7. The establishment operator should apply HACCP principles. To the greatest extent practicable, the HACCP principles should also be applied in the design and implementation of hygiene measures throughout the entire food chain.
8. The competent authority should define the role of those personnel involved in meat hygiene activities where appropriate, including the specific role of the veterinary inspector.

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[1] Specific meat hygiene requirements should address biological, chemical and physical hazards, and pathophysiological and other characteristics associated with suitability for human consumption.

[2] Codex Committee on Food Hygiene, proposed draft Principles and Guidelines for the Conduct of Microbiological Risk Management (CX/FH 03/7 and ALINORM 03/13A paras. 78–98); Codex Committee on General Principles, proposed draft Working Principles for Risk Analysis (CX/GP 02/3); Report of a Joint FAO/WHO Consultation on Principles and Guidelines for Incorporating Microbiological Risk Assessment in the Development of Food Safety Standards, Guidelines and Related Texts; Kiel, Germany, 18–22 March 2002 (ALINORM 03/16A – Appendix II, p. 30).

9. The range of activities involved in meat hygiene should be carried out by personnel with the appropriate training, knowledge, skills and ability as and where defined by the competent authority.
10. The competent authority should verify that the establishment operator has adequate systems in place to trace and withdraw meat from the food chain. Communication with consumers and other interested parties should be considered and undertaken where appropriate.
11. As appropriate to the circumstances, the results of monitoring and surveillance of animal and human populations should be considered with subsequent review and/or modification of meat hygiene requirements whenever necessary.
12. Competent authorities should recognize the equivalence of alternative hygiene measures where appropriate, and promulgate meat hygiene measures that achieve required outcomes in terms of safety and suitability and facilitate fair practices in the trading of meat.

Source: FAO/WHO. 2004. Draft code of hygienic practice for meat.
In *Report of the 10th Session of the Codex Committee on Meat Hygiene.* Alinorm 04/27/16. Rome (available at ftp://ftp.fao.org/codex/Alinorm04/AL04_16e.pdf).

Glossary and abbreviations

GLOSSARY TERMS

Abattoir

Any establishment where specified animals are slaughtered and dressed for human consumption and that is approved, registered and/or listed by the competent authority for such purposes.

Animal

Animals of the following types:

- domestic ungulates;
- domestic solipeds;
- domestic birds, i.e. poultry;
- lagomorphs;
- farmed game;
- farmed game birds, including ratites;
- wild game, i.e. wild land mammals and birds that are hunted (including those living in enclosed territory under conditions of freedom similar to those of wild game);
- animals as otherwise specified by the competent authority.

Ante-mortem inspection

Any procedure or test conducted by a competent person on live animals for the purpose of judgement of safety and suitability and disposition.

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Carcass

The body of an animal after dressing.

Chemical residues

Residues of veterinary drugs and pesticides as described in the Definitions for the Purpose of the Codex Alimentarius (FAO/WHO, 2001).

Cleaning

The removal of soil, food residue, dirt, grease or other objectionable matter.

Clonic phase

Kicking/convulsive period after pre-slaughter stunning (see also *Tonic phase*).

Codex maximum residue limit (MRL) for pesticides

The maximum concentration of a pesticide residue (expressed as mg/kg) recommended by the Codex Alimentarius Commission to be legally permitted in or on food commodities and animal feeds. MRLs are based on good agricultural practice (GAP) data, and foods derived from commodities that comply with the respective MRLs are intended to be toxicologically acceptable.

Codex maximum residue limit (MRL) for veterinary drugs

The maximum concentration of residue resulting from the use of a veterinary drug (expressed in mg/kg or µg/kg on a fresh weight basis) that is recommended by the Codex Alimentarius Commission to be legally permitted or recognized as acceptable in or on a food.

Commensal
An organism that lives in or on the body and does not cause illness. Some of these can cause illness if they are transferred to foods.

Competent authority
The official authority charged by the government with the control of meat hygiene, including setting and enforcing regulatory meat hygiene requirements.

Competent body
A body officially recognized and overseen by the competent authority to undertake specified meat hygiene activities.

Competent person
A person who has the training, knowledge, skills and ability to perform an assigned task, and who is subject to requirements specified by the competent authority.

Condemned
Examined and judged by a competent person, or otherwise determined by the competent authority, as being unsafe or unsuitable for human consumption and requiring appropriate disposal.

Contaminant
Any biological or chemical agent, foreign matter or other substance not intentionally added to food that may compromise food safety or suitability.

Contamination
The introduction or occurrence of a contaminant in food or the food environment.

Corneal reflex
A reflex/blinking movement elicited by touching the eyeball; a brain-stem reflex whose presence indicates brain-stem function.

Corrective action
Procedures to be followed when a deviation occurs.

Critical control point (CCP)
A point, step or procedure in a food process at which control can be applied and, as a result, a food safety hazard can be prevented, eliminated or reduced to acceptable levels.

Critical limit
The maximum or minimum value to which a physical, biological or chemical hazard must be controlled at a critical control point to prevent, eliminate or reduce to an acceptable level the occurrence of the identified food safety hazard.

Disease or defect
Any abnormality affecting safety and/or suitability.

Disinfection
The reduction, by means of chemical agents and/or physical methods, of the number of micro-organisms in the environment, to a level that does not compromise food safety or suitability.

Dressing
The progressive separation of the body of an animal into a carcass and other edible and inedible parts.

Emergency slaughter
The immediate slaughter of an animal for reasons of meat hygiene or animal welfare, or to prevent the spread of disease.

Epileptic activity/seizure
Activity seen in an electrically stunned animal.

Equivalence
The capability of different meat hygiene systems to meet the same food safety and/or suitability objectives.

Establishment
A building or area used for performing meat hygiene activities that is approved, registered and/or listed by the competent authority for such purposes.

Establishment operator
The person in control of an establishment who is responsible for ensuring that the regulatory meat hygiene requirements are met.

Evisceration
Removal of the internal organs from the abdominal and thoracic cavities of a carcass.

Examination
Detailed investigation, using clinical instruments such as a stethoscope or thermometer.

■

Feed (feedingstuff)
Any single or multiple materials, whether processed, semi-processed or raw, which are intended to be fed directly to food-producing animals.

Feed additives
Any intentionally added ingredient not normally consumed as feed by itself, whether or not it has a nutritional value, which affects the characteristics of feed or animal products.

Feed ingredient
A component part or constituent of any combination or mixture making up a feed, whether or not it has a nutritional value in the animal's diet, including feed additives. Ingredients are of plant, animal or aquatic origin, or other organic or inorganic substances.

Food hygiene
All conditions and measures necessary to ensure the safety and suitability of food at all stages of the food chain.

Food safety
Assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use.

Food safety objective (FSO)
The maximum frequency and/or concentration of a hazard in a food at the time of consumption that provides the appropriate level of protection.

Food suitability
Assurance that food is acceptable for human consumption according to its intended use.

Fresh meat
Meat that apart from refrigeration has not been treated for the purpose of preservation other than through protective packaging and which retains its natural characteristics.

■

Good hygienic practice (GHP)
All practices regarding the conditions and measures necessary to ensure the safety and suitability of food at all stages of the food chain.

■

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

Hazard
A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect.

Hazard characterization
The qualitative and/or quantitative evaluation of the nature of the adverse health effects associated with biological, chemical and physical agents that may be present in food. For chemical agents, a dose-response assessment should be performed if the data are obtainable.

Hazard identification
The identification of biological, chemical and physical agents capable of causing adverse health effects and which may be present in a particular food or group of foods.

Head-to-back stunning
Electrical stunning that induces an effective stun and a cardiac arrest.

■

Inedible
Examined and judged by a competent person, or otherwise determined by the competent authority, to be unsuitable for human consumption.

Inspection
Visual process of observation; the aim is to screen for animals that may then require examination.

Isolation pens
Special pens in which animals can be held, separated from their congeners, to facilitate veterinary inspection or treatment.

■

Loading dock
A raised area level with the deck of a vehicle to facilitate easy loading of animals on to the vehicle.

■

Maximum residue limits
see *Codex maximum residue limit for pesticides* and *Codex maximum residue limit for veterinary drugs.*

Meat
All parts of an animal that are intended for, or have been judged as safe and suitable for, human consumption.

Meat hygiene
All conditions and measures necessary to ensure the safety and suitability of meat at all stages of the food chain.

Minced meat
Boneless meat that has been reduced to fragments.

Notifiable disease
A disease that must be reported to the competent authority when its existence is known or suspected (e.g. anthrax with sudden death, foot-and-mouth disease, rinderpest, swine fever).

Official inspector
A competent person who is appointed, accredited or otherwise recognized by the competent authority to perform official meat hygiene activities on behalf of, or under the supervision of, the competent authority.

Organoleptic inspection
Using the senses of sight, touch, taste and smell for identification of diseases and defects.

Pathogen
A specific causative agent (usually a bacterium) of disease.

Pelt-burn
Burn on skin on the back of sheep caused by localized contact by the rear electrode (electrical stunning). It can be overcome by application of copious amounts of water.

Performance criteria
The required outcome of one or more control measures at a step or a combination of steps that contribute to assuring the safety of a food.

Polishing
Rubbing (e.g. by brush) or scraping (e.g. by knife) the skin of pig carcasses after singeing to remove all remnants of bristle.

Post-mortem inspection
Any procedure or test conducted by a competent person on all relevant parts of slaughtered/killed animals for the purpose of judgement of safety, suitability and disposition.

Post-stun convulsions
Uncontrollable physical/kicking activity of limbs after electrical or captive bolt stunning.

Pre-slaughter handling
All handling of animals from their selection for slaughter on the farm to their point of stun at the abattoir.

Preventive measure
Physical, chemical or other means that can be used to control an identified food safety hazard.

Primary production
All those steps in the food chain constituting animal production and transport of animals to the abattoir, or hunting and transporting wild game to a game depot.

Process control
All conditions and measures applied during the production process that are necessary to achieve safety and suitability of meat.

Process criteria
The process control parameters (e.g. time, temperature, dose) at a specified step that can be applied to achieve performance criteria.

Prolapse
The condition where an organ has fallen or become displaced from its normal position and may subsequently protrude from the body.

■

Quality assurance (QA)
All the planned and systematic activities implemented within the quality system and demonstrated as needed to provide adequate confidence that an entity will fulfil requirements for quality.

Quality assurance (QA) system
The organizational structure, procedures, processes and resources needed to implement quality assurance.

■

Raw meat
Fresh meat, minced meat or mechanically separated meat.

Ready-to-eat (RTE) products
Products that are intended to be consumed without any further biocidal steps.

Reaming tool
A special metal device used for scraping off the carbon deposits and cleaning inside the barrel of a captive bolt gun.

Responsible establishment official
The individual with overall authority on site or a higher-level official of the establishment.

Rhythmic breathing
Brain-stem reflex whose presence indicates brain-stem function.

Risk
A function of the probability of an adverse health effect and the severity of that effect, consequential to a hazard or hazards in food.

Risk analysis
A process consisting of three components: risk assessment, risk management and risk communication.

Risk assessment
A scientifically based process consisting of the following steps: (i) hazard identification, (ii) hazard characterization, (iii) exposure assessment, and (iv) risk characterization.

Risk characterization
The qualitative and/or quantitative estimation, including attendant uncertainties, of the probability of occurrence and severity of known or potential adverse health effects in a given population, based on hazard identification, hazard characterization and exposure assessment.

Risk communication
The interactive exchange of information and opinions throughout the risk analysis process concerning hazards and risks, risk-related factors and risk perceptions among risk assessors, risk managers, consumers, industry, the academic community and other interested parties, including the explanation of risk assessment findings and the basis of risk management decisions.

Risk management
The process, distinct from risk assessment, of weighing policy alternatives, in consultation with all interested parties, considering risk assessment and other factors relevant for the health protection of consumers and for the promotion of fair trade practices and, if needed, selecting appropriate prevention and control options.

Risk-based
Containing performance and/or process criteria developed according to risk analysis principles.

■

Safe for human consumption
Safe for human consumption according to the following criteria:
- has been produced by applying all food safety requirements appropriate to its intended end-use;
- meets risk-based performance and process criteria for specified hazards; and
- does not contain hazards at levels that are harmful to human health.

Shackling
Coupling the hind limbs of a stunned animal using a chain or similar to enable hoisting and sticking.

Specified risk material (SRM)
These are the animal tissues that are most at risk of harbouring the transmissible spongiform encephalopathy (TSE) agent. These tissues must be removed from the food and feed chains to avoid the risk of recycling the TSE agent. They are separately collected at slaughterhouses and disposed of by direct incineration or after pre-processing. Countries define SRM differently, although all include the brain and spinal cord of cattle over 30 months old. In the European Union the following organs are considered SRM: skull (including brain and eyes), spinal cord and vertebral column (including dorsal root ganglia but **not** vertebrae of tail nor transverse processes of lumbar and thoracic vertebrae) from cattle older than 12 months, tonsils and intestines and mesentery from cattle of all ages.

Sterilize
Use physical or chemical procedure to destroy all microbial life, including highly resistant bacterial endospores.

Sticking/exsanguination
Severance of blood vessels in the neck or in the chest.

Stockman/stock handler
Anybody who is involved with the care, health and welfare of animals.

Suitable for human consumption

Suitable for human consumption according to the following criteria:

- has been produced under hygienic conditions as outlined in the *Draft code of hygienic practice for meat*;
- is appropriate to its intended use; and
- meets outcome-based parameters for specified diseases or defects as established by the competent authority.

■

Tonic phase

Rigid period during and/or immediately after pre-slaughter stunning (see also *Clonic phase*).

Traceability

The ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be, incorporated into a food or feed, through all stages of production, processing and distribution.

■

Undesirable substances

Contaminants and other substances that are present in and/or on feed and feed ingredients and constitute a risk to the health of the consumer, including food safety-related animal health issues.

■

Verification

Activities performed by the competent authority and/or competent body to determine compliance with regulatory requirements.

Verification (operator)

The continual review of process control systems, including corrective and preventive actions, to ensure that regulatory and/or specified requirements are met.

Veterinary inspector

An official inspector who is professionally qualified as a veterinarian and officially carries out meat hygiene activities as specified by the competent authority.

■

Zoonosis/zoonotic disease

Animal disease that can be transmitted to humans.

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ABBREVIATIONS AND ACRONYMS

Animal diseases

BHD
bovine herpes dermophatic disease

BSE
bovine spongiform encephalopathy

BVD
bovine viral diarrhoea

CBPP
contagious bovine pleuropneumonia

COPD
chronic obstructive pulmonary disease

CWD
chronic wasting disease

FMD
foot-and-mouth disease

IBR
infectious bovine rhinotracheitis

MCF
malignant catarrhal fever

NWS
New World screwworm

OWS
Old World screwworm

RP
rinderpest

TME
transmissible mink encephalopathy

TRP
traumatic reticuloperitonitis

TSEs
transmissible spongiform encephalopathies

vCJD
variant Creutzfeldt-Jakob disease

VS
vesicular stomatitis

Institutions and organizations

CAC
Codex Alimentarius Commission

CCFH
Codex Committee on Food Hygiene

EC
European Commission

FDA/CFSAN
United States Food and Drug Administration Center for Food Safety and Applied Nutrition

FAO
Food and Agriculture Organization of the United Nations

FSIS USDA
Food Safety and Inspection Service of the United States Department of Agriculture

JECFA
Joint Expert Committee on Food Additives

OIE
World Organisation for Animal Health

WHO
World Health Organization

WTO
World Trade Organization

Other

ADI
acceptable daily intake

AI
artificial insemination

ALOP
appropriate level of protection

CBG
captive bolt gun

CCP
critical control point

cfu
colony forming units

CL
critical limit

CNS
central nervous system

DCB
dark cutting beef

DFD
dark, firm, dry (meat)

FSO
food safety objective

GAP
good agricultural practice

GHP
good hygienic practice

GMP
good manufacturing practice

GVP
good veterinary practice

HACCP
Hazard Analysis and Critical Control Point

MPL
maximum permissible level

MRA
microbiological risk assessment

MRL
maximum residue limit

MSQA
meat safety quality assurance system

PCBs
polychlorinated biphenyls

PSE
pale, soft, exudative (pork)

QA
quality assurance

RFID
radio frequency identification device

RH
relative humidity

SPS
Sanitary and Phytosanitary (Agreement)

SRM
specified risk material

STEC
Shiga toxin-producing *Escherichia coli*

TBT
Technical Barriers to Trade (Agreement)

TQM
total quality management

Introduction

Meat has traditionally been viewed as the culprit for a significant proportion of human food-borne disease. Although the spectrum of meat-borne diseases of public health importance has changed with changing production and processing systems, in recent years human surveillance studies of specific meat-borne pathogens, such as *Escherichia coli* O157:H7, *Salmonella* spp., *Campylobacter* spp. and *Yersinia enterocolitica*, have shown that the problem continues. In addition to existing biological, chemical and physical hazards, new hazards are also appearing, for example, the agent of bovine spongiform encephalopathy (BSE). Furthermore, consumers increasingly have expectations about suitability issues that are not necessarily of human health significance.

A contemporary risk-based approach to meat hygiene requires that hygiene measures should be applied at those points in the food chain where they will be of greatest value in reducing food-borne risks to consumers. This should be reflected in the application of specific measures that are based on science and risk assessment, and a greater emphasis on prevention and control of contamination during processing. Application of the Hazard Analysis and Critical Control Point (HACCP) principles is an essential element. Risk-based programmes have proved successful in achieving hazard control to the extent required for consumer protection. They are based on the required outcome rather than on detailed and prescriptive measures.

A number of national governments are implementing systems that redefine the respective roles of industry and government in delivering meat hygiene activities. Irrespective of the delivery systems, the competent authority is responsible for defining the role of personnel involved in meat hygiene activities where appropriate, and verifying that all regulatory requirements are met.

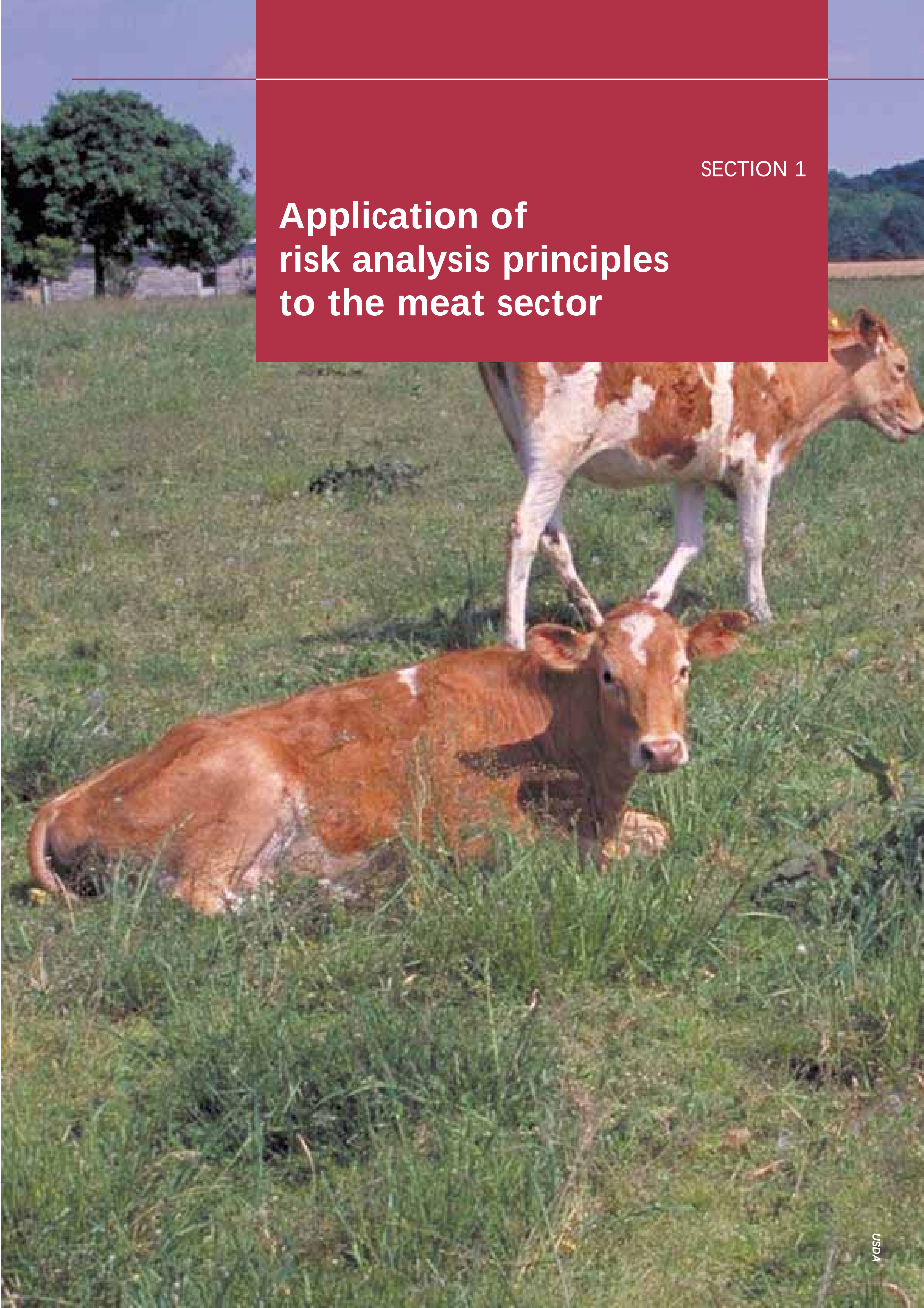
The principles of food safety risk management should be incorporated wherever appropriate in the design and implementation of meat hygiene programmes. Further, newly recognized meat-borne risks to human health may require measures in addition to those that are usually applied in meat hygiene; for example, the potential for zoonotic transmission of central nervous system disorders of slaughtered livestock means that additional animal health surveillance programmes may need to be undertaken.

This manual provides updated comprehensive information and practical guidelines for the implementation of the new *Draft code of hygienic practice for meat*, when adopted by the Codex Alimentarius Commission. The publication is intended to guide managers of abattoirs and the meat industry. It will also be of value to veterinarians engaged in meat inspection, with their supervisory roles in meat hygiene. The book is published in detachable modules and can also serve as a training manual.

This manual is not a substitute for any regulations that apply. Rather, it is designed to provide a quick reference to current good practice and avoids lengthy text normally found in regulatory documents. The procedures outlined are recommendations for good practice, based on the new Codex code and on research in the relevant areas. The subject matter covers all the procedures, facilities and personnel considerations that impinge on the safety of meat and on the welfare of the animals – including the risk from BSE-infected animals – commencing with the animals on the farm, to the slaughterhouse/processing plant and extending to post-mortem inspection of carcasses and staff training.

SECTION 1

Application of risk analysis principles to the meat sector



USDA

INTRODUCTION TO MEAT HYGIENE

Food hygiene is defined as "all conditions and measures necessary to ensure the safety and suitability of food at all stages of the food chain" (FAO/WHO, 1999a). In the practical world of meat hygiene, this will require contributions from a range of stakeholders, including industry and government.

Meat hygiene is a demanding science and must deal with different classes of hazards. Chemical hazards entering the food chain at the level of primary production include: residues of veterinary drugs and pesticides, environmental and industrial contaminants and illegal growth promotants. For many years, meat inspection focused on forms of microbiological contamination that cause macroscopic lesions. This includes, for example, tuberculosis, anthrax, salmonellosis in pigs, and parasites such as *Cysticercus.* Now that these forms of contamination are under control in most countries, better monitoring and surveillance make it possible to deal with other microbiological pathogens that can be detected only by laboratory techniques. The type and prevalence of these pathogens change markedly with different production, processing and food-handling practices in different countries, and new zoonoses such as *Escherichia coli* O157:H7 and the infectious agent of bovine/transmissible spongiform encephalopathy (BSE/TSE) continue to emerge.

Recent reviews identify microbiological hazards carried primarily by healthy animals as causing the majority of meat-borne risks to human health, e.g. *Salmonella enteritidis, Campylobacter jejuni, E. coli, Clostridium perfringens, Yersinia enterocolitica* and *Listeria monocytogenes.*

Recently gained knowledge reveals that the median infectious dose for different meat-borne pathogens may range from a few cells, e.g. *E. coli* O157:H7, to many millions of cells, e.g. several *Salmonella* spp. For *Salmonella* serovars, the European Commission Scientific Committee on Veterinary Measures relating to Public Health estimates the infectious illness dose to range from 10^1 to 10^{11} colony forming units (cfu). This has obvious implications for the implementation of food safety measures by industry.

In many situations, prevention and control of hazards of public health importance are achieved in parallel to prevention and control of diseases and conditions of animal health importance. This duality of functions becomes especially important in a "production-to-consumption" approach to food control, where veterinary competence and administration can be shared while achieving both public health and animal health objectives.

Risk management in meat hygiene only applies to safety aspects. Although risk management principles could be adapted to assist in management of suitability characteristics of meat, this will not be explored in this manual.

A RISK-BASED APPROACH TO FOOD HYGIENE

In recent times, both national governments and standard-setting bodies for food in international trade have introduced the risk-based approach to food hygiene (Box 1.1). This has largely been a consequence of the international trade provisions of the World Trade Organization Sanitary and Phytosanitary (WTO SPS) Agreement, and obligations to justify food hygiene measures on the basis of science and risk assessment.

Governments and industry have also been keen to adopt risk assessment as a tool to develop more efficient and cost-effective food hygiene programmes. Many countries now consider that food control measures should be proportionate to the risks presented by specific food-borne hazards, with regulatory programmes focusing in a preventive manner on those hazards that present the greatest risks to human health. Notwithstanding this, risk management must also consider the feasibility and practicality of available control measures. The outcome should be hygiene measures applied at those points in the food chain where they will be of greatest value in reducing food-borne risks to consumers.

The Codex Alimentarius Commission (Codex) is responsible for setting standards for food in international trade and has now developed a large body of work on risk analysis (FAO/WHO, 2001a). The Codex *General principles of food hygiene* (as reprinted in FAO/WHO, 2001b) state that: In deciding whether a requirement is necessary or appropriate, an assessment of the risk should be made . Risk analysis is also increasingly becoming cross-sectoral in nature, and risk-based biosecurity processes for public, animal and plant health should be applied with the greatest degree of consistency possible (FAO, 2002).

Risk analysis in food safety has its contemporary roots in the emerging global climate of free trade that is based on removal of barriers constituting unjustified protection of domestic economic advantage. However, the global community fully recognizes the sovereign right of countries to place appropriate controls on food products crossing their borders so as to protect human health. The WTO SPS Agreement represents an effort of the global community to establish principles and guidelines governing the establishment and implementation of such controls.

Box 1.1 **Risk-based approach**

A **risk-based approach** contains performance and/or process criteria developed according to risk analysis principles.

A ***performance criterion*** is the required outcome of one or more control measures at a step or a combination of steps that contribute to assuring the safety of a food.

Process criteria are the process control parameters (e.g. time, temperature, dose) at a specified step that can be applied to achieve performance criteria.

The process of **risk analysis** comprises three steps:

- **Risk assessment.** A quantitative evaluation of information on potential health hazards from exposure to various agents. It involves four interrelated steps:
  - Identification of the hazard and comprehension of the danger it represents, the impact in terms of human health and the circumstances under which the danger is present (hazard identification).
  - Qualitative and/or quantitative evaluation of the adverse effects of the hazard on human health (hazard characterization).
  - Qualitative and/or quantitative evaluation of the likely degree of consumption or intake of the hazardous agent (exposure assessment).
  - Integration of the first three steps into an estimate of the likely adverse effects on the target population (risk characterization).
- **Risk management.** A process of weighing policy alternatives in the light of the results of risk assessment and, if required, selecting and implementing appropriate control options including regulatory measures. The goal of the risk management process is to establish the significance of the estimated risk, to compare the costs of reducing this risk with the benefits gained, to compare the estimated risks with the societal benefits derived from incurring the risk and to carry out the political and institutional process of reducing the risk. The outcome of the risk management process is the development of standards, guidelines and other recommendations for food safety.
- **Risk communication.** An interactive process of exchange of information and opinion among risk assessors, risk managers and other interested parties. Risk communication provides the private and public sector with the information necessary for preventing, reducing or minimizing food risks to acceptable levels through systems of food quality and safety management by either mandatory or voluntary means.

Source: FAO, 1998.

PRACTICAL APPLICATION OF A RISK-BASED APPROACH IN MEAT HYGIENE

The practical application of risk management principles in meat hygiene requires an understanding of:

- the components of a meat hygiene programme;
- application of a risk analysis framework;
- risk assessment;
- risk management;
- risk communication;
- the different roles of industry, government and other stakeholders in the design and implementation of a meat hygiene programme.

Implementing risk-based meat hygiene programmes presents particular challenges in developing countries, which are often under-resourced in terms of regulatory systems and scientific capacity. Codex has recommended that risk assessment should be based on global data, including that from developing countries, and international standards should take into account the economic consequences and the feasibility of risk management options in developing countries (FAO/WHO, 1999b).

BUILDING A MEAT HYGIENE PROGRAMME

Most meat production, processing, storage, distribution and retail activities will require tailor-made programmes that document all hygiene requirements. Industry has the primary responsibility to document and implement such programmes, with overview and verification by the government regulatory authority having jurisdiction (hereafter referred to as the competent authority). Three building blocks can be used in the practical development of a specific meat hygiene programme:

1. Good hygienic practice (GHP)
2. The Hazard Analysis and Critical Control Point (HACCP) system, and
3. Risk assessment

GOOD HYGIENIC PRACTICE

Meat hygiene programmes have traditionally been based on good hygienic practice (GHP), which provides a baseline food control programme. GHP generally consists of a qualitative description of all practices regarding the conditions and measures necessary to ensure the safety and suitability of food. Many practices are based on empirical experience and practice, and cover both the food production process and the food production environment. It should be noted that GHP is the only component of a meat hygiene programme that addresses non-food safety issues.

Regulatory GHP requirements are generally prescriptive and describe process requirements rather than outcomes. Some quantitative specifications may be included, e.g. chlorine levels for potable water, aerobic plate counts for working surfaces, and acceptable defect rates for visible contamination on chilled carcasses. In most cases, the effectiveness of the GHP components of a meat hygiene programme will not be able to be validated in terms of achieving a particular level of consumer protection, i.e. they are not risk-based.

The Codex *Recommended international code of practice: general principles of food hygiene* (FAO/WHO, 1999a) provides a GHP platform for development of individual meat hygiene programmes. Generic GHP for meat hygiene is presented in the Codex proposed *Draft code of hygienic practice for meat* (FAO/WHO, 2004).

APPLICATION OF HACCP PRINCIPLES

HACCP is a more sophisticated food control system than GHP, which identifies, evaluates, and controls hazards which are significant for food safety (FAO/WHO, 1999a) (Box 1.2). Application of HACCP principles should follow development of the GHP component of a meat hygiene programme.

Application of HACCP principles may result in identification of one or more critical control points (CCPs) and implementation of the elements of a HACCP plan. Given the current evolution of HACCP, the designation of a CCP at a particular step in the food chain may be based on empirical scientific judgement, or it may be more genuinely based on risk assessment.

If no CCPs are identified, then the meat hygiene programme will remain as one based on GHP. Critical limits (CLs) at a CCP may be designated as regulatory limits by the competent authority.

Box 1.2 The Hazard Analysis and Critical Control Point (HACCP) system

HISTORY OF HACCP

HACCP has become synonymous with food safety. It is a worldwide-recognized systematic and preventive approach that addresses biological, chemical and physical hazards through anticipation and prevention, rather than through end-product inspection and testing.

The HACCP system for managing food safety concerns grew from two major developments. The first breakthrough was associated with W.E. Deming, whose theories of quality management are widely regarded as a major factor in turning around the quality of Japanese products in the 1950s. Dr Deming and others developed total quality management (TQM) systems that emphasized a total systems approach to manufacturing that could improve quality while lowering costs.

The second major breakthrough was the development of the HACCP concept itself. The HACCP concept was pioneered in the 1960s by the Pillsbury Company, the United States Army and the United States National Aeronautics and Space Administration (NASA) as a collaborative development for the production of safe foods for the United States space programme. NASA wanted a " zero defects" programme to guarantee the safety of the foods that astronauts would consume in space. Pillsbury therefore introduced and adopted HACCP as the system that could provide the greatest safety while reducing dependence on end-product inspection and testing. HACCP emphasized control of the process as far upstream in the processing system as possible by utilizing operator control and/or continuous monitoring techniques at critical control points. Pillsbury presented the HACCP concept publicly at a conference for food protection in 1971. The use of HACCP principles in the promulgation of regulations for low-acid canned food was completed in 1974 by the United States Food and Drug Administration (FDA). In the early 1980s, the HACCP approach was adopted by other major food companies.

The United States National Academy of Science recommended in 1985 that the HACCP approach be adopted in food processing establishments to ensure food safety. More recently, numerous groups, including for example the International Commission on Microbiological Specifications for Foods (ICMSF) and the International Association of Milk, Food and Environmental Sanitarians (IAMFES), have recommended the broad application of HACCP to food safety.

THE CODEX ALIMENTARIUS GENERAL PRINCIPLES OF FOOD HYGIENE

Recognizing the importance of HACCP to food control, the twentieth session of the Codex Alimentarius Commission, held in Geneva, Switzerland from 28 June to 7 July 1993, adopted *Guidelines for the application of the Hazard Analysis Critical Control Point (HACCP) system* (ALINORM 93/13A, Appendix II). The Commission was also informed that the draft revised *General principles of food hygiene* would incorporate the HACCP approach.

The revised *Recommended international code of practice: general principles of food hygiene* (CAC/RCP 1-1969, Rev 3 [1997]) was adopted by the Codex Alimentarius Commission during its twenty-second session in June 1997. *The Hazard Analysis and Critical Control Point (HACCP) system and guidelines for its application* is included as its Annex.

The Codex *General principles of food hygiene* lay a firm foundation for ensuring food hygiene. They follow the food chain from primary production through to the consumer, highlighting the key hygiene controls at each stage and recommending a HACCP approach wherever possible to enhance food safety. These controls are internationally recognized as essential to ensuring the safety and suitability of food for human consumption and international trade.

ADVANTAGES OF HACCP

The HACCP system, as it applies to food safety management, uses the approach of controlling critical points in food handling to prevent food safety problems. The system, which is science-based and systematic, identifies specific hazards and measures for their control to ensure the safety of food.

The HACCP system can be applied throughout the food chain from the primary producer to the consumer. Besides enhancing food safety, other benefits of applying HACCP include more effective use of resources, savings to the food industry and more timely response to food safety problems.

HACCP enhances the responsibility and degree of control at the level of the food industry. A properly implemented HACCP system leads to greater involvement of food handlers in understanding and ensuring food safety, thus providing them with renewed motivation in their work. Implementing HACCP does not mean undoing quality assurance procedures or good manufacturing practices already established by a company; it does, however, require a revision of these procedures as part of the systematic approach and for their appropriate integration into the HACCP plan.

The application of the HACCP system can aid inspection by food control regulatory authorities and promote international trade by increasing buyers' confidence.

Any HACCP system should be capable of accommodating change, such as advances in equipment design, changes in processing procedures or technological developments.

Source: adapted from FAO, 1998.

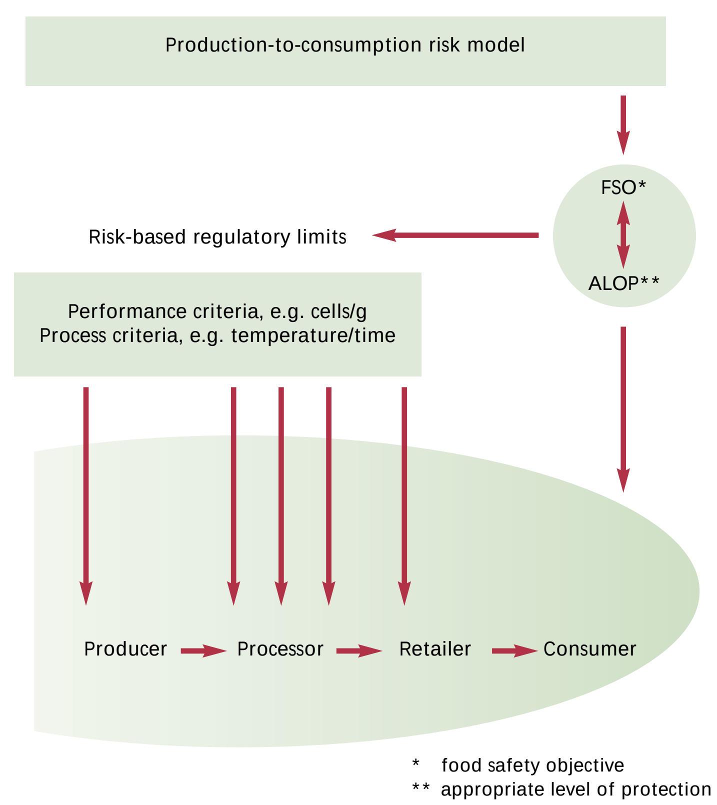
RISK ASSESSMENT

Food safety aspects of meat hygiene programmes should be based on considerations of risks to consumers to the extent possible and practical. A risk-based meat hygiene programme requires some understanding of the level of consumer protection that is to be achieved by particular measures. This entails knowledge of the level of control of hazards that is attained at a particular step in the food chain relative to the expected level of consumer protection. For food in international trade, this is called the appropriate level of protection (ALOP). Establishing this linkage will mainly be the domain of government and scientific institutions rather than industry. The linkage may be expressed in quantitative terms, e.g. by use of a risk assessment model linking hazard levels and consumer risks, or may be established in qualitative terms, e.g. by linking hazard levels to the level of consumer protection inherent in broader public health goals.

If a segment of a food chain has undergone risk assessment, implementation of a risk-based meat hygiene programme may involve establishment of regulatory limits for hazard control.

In other situations, the risk assessment model may be used to determine which hygiene measures have the most significant impact on reducing risk, and these could be specified in regulations independent of regulatory limits, e.g. a requirement to wash animals pre-slaughter.

FIGURE 1.1 **Use of risk-based regulatory limits in developing a food safety programme**



Source: S. Hathaway, New Zealand Food Safety Authority.

RISK-BASED REGULATORY LIMITS

Risk-based regulatory limits (Figure 1.1) can be expressed in several ways.

Performance criteria

A performance criterion is a quantitative expression of the hazard level at a particular step in the food chain that still provides the ALOP. It can be established at any step in the production-to-consumption food chain, as long as a link is established between the level of hazard at that step and the level of consumer protection that is afforded when the food is used according to its intended end use. This requires a risk model.

If the hazard is a microbiological pathogen, a performance criterion specified in terms of microbial numbers is unlikely to be of a nature that can be verified on a real-time basis as part of a HACCP plan. For biological hazards, a risk-based regulatory limit established by the competent authority is likely to be expressed as a process criterion.

Process criteria

A process criterion is a quantifiable characteristic at a specified step or combination of steps in the food chain that achieves a performance objective. Process criteria should be measurable in real time, e.g. temperature/time for retorting of cans, examination for zero visible faecal contamination on fresh carcasses, and will most likely constitute CLs at CCPs. In some cases, process criteria may be characteristics of the food, e.g. salt content, available water content.

Food safety objectives

A food safety objective (FSO) is a performance criterion at the point of consumption of the food. In most cases it will be derived from a risk assessment model, and provides the competent authority with a validated means of establishing performance criteria (and process criteria) at other points in the food chain. FSOs are unlikely to be specified in regulations.

Other regulatory limits

Maximum residue limits (MRLs) or maximum permitted levels for chemical hazards in foods may be established by the competent authority as monitoring tools to assess whether the acceptable daily intake (ADI), as established by the scientific advisory body such as the Joint FAO/WHO Expert Committee on Food Additives (JECFA), is likely to be exceeded. In this case, the ADI reflects the FSO.

Microbiological criteria have long been used to determine the acceptability or otherwise of a consignment lot of food according to the microbiological results of a specified sampling plan. Despite some use as regulatory limits for processed meat by competent authorities, linkages between microbiological criteria and the ALOP for a particular food/hazard combination are rarely validated by use of a risk assessment model.

Non-compliance

Compliance with regulatory requirements by industry is an essential part of a risk-based meat hygiene system:

- Non-compliance with the GHP components of a meat hygiene programme should result in correction of process deficiencies within some reasonable time period.
- Non-compliance with a CL at a CCP should result in a review of the meat hygiene programme, and may result in non-acceptability of the product involved.
- Non-compliance with a regulatory limit derived from risk assessment should result in immediate and stringent review of the meat hygiene programme, with probable non-acceptability of the product involved.

It should be noted that in addition to regulatory use, risk-based limits can be established by industry for their own food safety purposes. In such cases, verification activities and responses to non-compliance should be fully documented. The competent authority may take compliance with industry limits into account when verifying regulatory requirements.

APPLYING A GENERIC FRAMEWORK FOR MANAGING RISKS

Design and implementation of risk-based meat hygiene programmes place specific demands on competent authorities and industry. Technical capability needs to be allocated to assess risks, and other components of risk analysis, i.e. risk management and risk communication, need to be effectively employed. Industry may choose to employ risk analysis independent of the activities of competent authorities.

Components of food safety risk analysis

Risk analysis constitutes an interplay of several multidisciplinary tasks. In a general sense, risk analysis is a structured process to determine:

- What can go wrong?
- How likely is it to go wrong?
- How serious would it be if it went wrong?
- What can be done to reduce the likelihood and/or seriousness of it going wrong?

Risk analysis is recognized as having three components: risk assessment, risk management and risk communication (Box 1.1).

Risk assessment

Risk assessment should, to the extent practicable, be a scientific exercise that generates a quantitative estimation of risks that may be associated with a particular food.

An estimate of risk is often described in terms of severity and frequency of adverse health effects, e.g. one death per million population per year. However, quantitative models are often unavailable because of resource or data constraints, and simplified tools can be useful as screening methods to generate qualitative risk assessments, e.g. high, medium and low risk, and risk rankings.

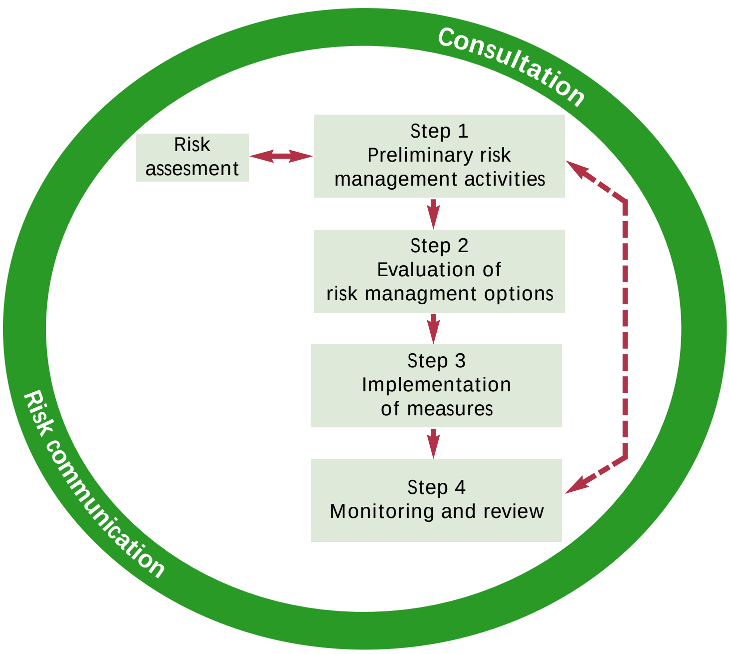
Risk management

An important part of risk management is a value-based decision on the desired level of public health protection, i.e. the ALOP. A range of factors need to be considered when evaluating the technical feasibility, practicality and cost of a meat hygiene programme compared to the desire to minimize food-borne risks to the greatest extent possible.

Risk communication

Risk assessment and risk management should be wrapped in a sea of communication that includes all stakeholders as appropriate, and facilitates the iterative and ongoing nature of all components of risk analysis.

FIGURE 1.2 **A generic framework for managing food-borne risks to human health**



Source: S. Hathaway, New Zealand Food Safety Authority.

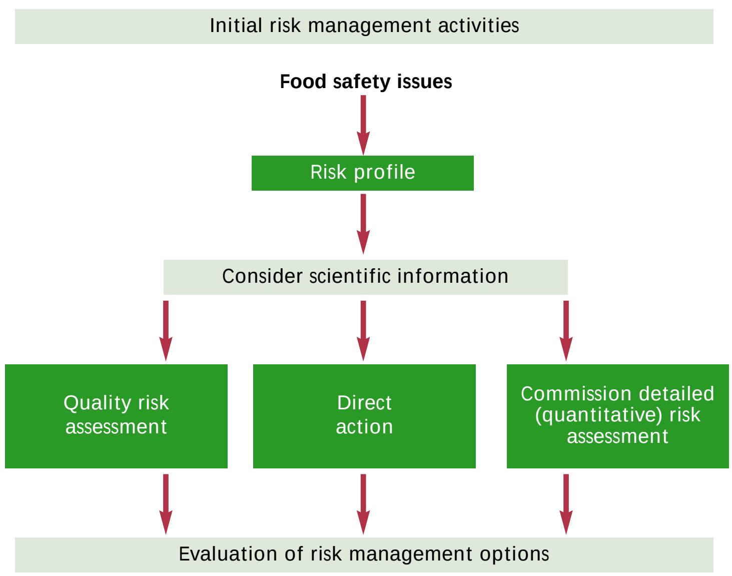
A GENERIC FRAMEWORK FOR MANAGING RISKS

The most important aspect of the design and implementation of a risk-based meat hygiene programme is systematic application of the principles of food safety risk management within the context of a generic framework for managing food-borne risks. This framework has four elements: preliminary risk management activities; evaluation of risk management options; implementation of measures; and monitoring and review (Figure 1.2).

Application of this framework will include the competent authority, industry and other stakeholders, e.g. science institutions and consumers. Each group will have different roles and responsibilities. The framework should be applied in an open, iterative and fully documented manner.

One of the most important practical reasons for implementing a generic framework for managing risks relates to the current lack of quantitative risk assessments for many hazards in meat products. Systematic application of a generic framework for managing risks, even in the absence of a quantitative risk estimate, will still result in most cases in enhanced meat hygiene programmes (Figure 1.3). Default or precautionary positions can be taken where data

FIGURE 1.3 **Initial risk management activities**



Source: S. Hathaway, New Zealand Food Safety Authority.

are limited or unavailable, pending further scientific studies.

Preliminary risk management activities

Following identification of a food safety issue, the initial process includes the establishment of a risk profile to place the issue within a particular context, and provide as much information as possible to guide further action by the competent authority. Risk profiling may also be used for ranking or prioritization of different food safety issues.

Risk profiling is one activity in preliminary risk management, and has been described as a systematic collection of information needed to make a decision on what will be done next and whether resources should be allocated to more detailed scientific assessment. Risk profiling is the responsibility of risk managers, and may contain information on the hazard, exposure to the hazard, adverse health effects, public health surveillance information, control measures and other information relevant to risk management decision-making.

Although not necessary in many cases, the risk manager may commission a detailed risk assessment as an independent scientific process to inform decision-making. If so, risk assessment policy should be established. Once a risk assessment has been received, the last task in preliminary risk management activities is for the competent authority to consider the results for completeness and appropriateness.

Risk assessment policy refers to the documented guidelines for policy choices and scientific value judgements that may be necessary at specific points in the risk assessment process, and which should preferably be agreed ahead of risk assessment.

Evaluation of risk management options

This is the process whereby potential risk management options are identified, and then selected according to appropriate decision-making criteria. It will usually involve balancing expectations in terms of minimizing risks against available food control measures, and may include reaching a decision on an ALOP. Although facilitated by the competent authority, both industry and consumers have critical inputs to this process.

Optimization of selected measures in terms of their efficiency, technological feasibility and practicality at the designated step in the food chain is an important goal. Meat hygiene measures should be implemented by industry at those steps in the food chain where there is maximum reduction of risk for the effort required. Various hygiene measures can be simulated in a risk assessment model to determine their individual impact on minimizing risks to consumers.

Implementation of measures

Implementation of meat hygiene measures by industry will usually be by means of a tailor-made programme that is built up as previously described. This will be based on GHP, and may contain one or more CCPs resulting from application of HACCP principles. Regulatory limits or procedures derived from risk assessment may be present. The final accountability for verification of the meat hygiene programme on an ongoing basis lies with the competent authority.

For some hazards, it may not be practical or cost effective for industry to implement hygiene measures on an individual premises basis, e.g. laboratory testing for chemical residues of one sort or another. National chemical residue programmes and a central laboratory administered by the competent authority can usually provide risk-based food safety assurances in such circumstances.

While flexibility in choice of individual meat hygiene measures at different steps in the food chain is a desirable element in a risk-based meat hygiene programme, the price of flexibility is validation. When a decision on a particular ALOP has been taken, different measures may be chosen by industry as long as they are capable of actually achieving that level of protection. This is at the heart of the principle of equivalence (see below). Following validation, ongoing verification of measures will assure that the ALOP is being achieved on an ongoing basis.

Monitoring and review

This risk management activity is represented by the gathering and analysing of data on human health so as to give an overview of food safety and consumer health. Monitoring (which includes surveillance) is usually carried out by national public health authorities and should identify new food safety problems as they emerge. Where there is evidence that required food safety goals are not being achieved, redesign of meat hygiene measures will be needed. Both the competent authority and industry will be involved in this task.

Unfortunately, there is a worldwide shortage of reliable monitoring data relating to meat-borne risks to consumers, and this has an impact on the ability to validate risk-based meat hygiene programmes.

RISK ASSESSMENT IN MEAT HYGIENE

It can be seen from the above description of a generic framework for managing risks that risk assessment is a separate and distinct scientific process. In most cases risk assessments will be commissioned by government and carried out by national science providers. Multidisciplinary skills are required. Risk assessments may employ qualitative and/or quantitative approaches, and vary widely in complexity. In some situations, industries may carry out their own risk assessments so as to enhance their meat hygiene programmes independently.

A comprehensive risk-based meat hygiene programme should address chemical, biological and physical hazards. Meat derived from different species of slaughtered animals, e.g. sheep and goats, and different types of slaughtered animals, e.g. farmed deer and wild deer, may have very different hazard profiles.

The risk assessment model

Ideally, a detailed risk assessment will incorporate four steps:

- **hazard identification:** the identification of biological, chemical and physical agents in food capable of causing adverse human health effects;
- **hazard characterization:** the qualitative or quantitative evaluation of the nature of the adverse health effects, ideally including human dose-response assessment;
- **exposure assessment:** the qualitative or quantitative evaluation of the likely intake of food-borne hazards by consumers, taking into account other hazard exposure pathways where relevant;
- **risk characterization:** the qualitative or quantitative estimation, including attendant uncertainties, of the probability of occurrence and severity of adverse health effects in a given population.

Industry can provide important inputs to exposure assessment by assisting with modelling of all steps in the food chain from production to consumption. For microbial hazards, industry data are often the only source of detailed information on hazard levels at each step during processing of meat.

Numerical risk estimates allow direct comparison of risks and different intervention strategies, whereas non-numerical risk estimates provide a less definitive basis for risk management decision-making. In the latter case, risk assessments provide an essential point for discussion, debate and preliminary risk ranking. They provide a methodical approach when food safety has a high priority but numerical methods are not available.

Chemical risk assessment

Large numbers of quantitative standards for chemical hazards in foods have been established for many years. Most take the form of MRLs. The ADI or acceptable daily intake is established by a separate safety evaluation process. The meat industry itself is very unlikely to be involved in risk assessment of chemicals.

Following hazard identification, ADIs for chemicals in foods are generally determined by extrapolation from a no adverse effect level animal model, and the ADI reflects the maximum amount of residues that can be absorbed daily by the consumer without risk to health, i.e. a pre-determined notional zero risk . This effectively is hazard characterization, and it is arrived at by imposition of arbitrary safety factors . Methods are now being developed for calculating reference doses for acute toxicity if this is a potential adverse health effect.

An ADI is a relatively crude estimate of the level of chronic dietary intake that is bearable without risk, and the impact of arbitrary safety factors that are embedded in the safety valuation process is not quantified. There is rarely an attempt to define the degree of uncertainty or describe the impact of this uncertainty on the standard-setting process. Thus the worst-case scenario that constitutes the general approach taken for intake of chemical hazards in foods is likely to be a marked overestimate of exposure in most cases.

Exposure characterization describes the exposure pathway for the hazard and predictions of dietary intake. It is usually composed of simple deterministic values for hazard levels at each step in the food chain; however, probabilistic models are emerging, e.g. for intake of pesticide residues.

Risk characterization corresponds in part to establishment of maximum limits for residues, e.g. MRLs for veterinary drugs, and ensuring compliance with the ADI. Maximum limits for chemical residues in foods are usually established so that the theoretical maximum daily intake of residues is lower than that allowable by the ADI. However, their establishment may be independent from the ADI-setting process (e.g. pesticides) and may involve a number of qualitative risk management factors. In some cases, risk characterization may include consideration of different types of chemical hazards and pathways. For example, when a substance is used as both a veterinary drug and a pesticide on plants, both routes can be taken into account when setting ADIs for animal-derived foods.

For unavoidable environmental contaminants, standards for chemical hazards are often related to maximum permissible levels (MPLs), i.e. there is tacit acceptance that it is not economically or technically feasible to apply the same notional zero risk model that is applied to other chemicals in the food supply.

Biological risk assessment

In the past, evaluation of food-borne risks associated with biological hazards in the food supply has been largely empirical and qualitative. The overall goal has been to reduce biological hazards to a level that is as low as reasonably achievable , with commensurate minimization of risks. In most cases, the actual level of risk associated with particular food control programmes is unknown.

The advent of robust predictive microbiology and PC-based software for simulated risk modelling, coupled with rapidly increasing demands from all stakeholders for risk-based microbiological food safety measures, is fuelling an emerging era of microbiological risk assessment (MRA). The highly resource-intensive nature of MRA means that this is mainly the domain of competent authorities and science institutions.

In general terms, MRA involves combining the outputs of exposure assessment and hazard characterization to characterize risk. Risk estimates can be qualitative, e.g. high, medium or low rankings, or presented in quantitative terms, e.g. risk per serving(s), risk per year. Recently, FAO and WHO have embarked on a series of expert consultations on MRA that represent an extensive and ongoing commitment. This work is heavily dependent on MRAs already commissioned by national governments.

Considerable challenges lie ahead in carrying out detailed MRAs for pathogen/food commodity combinations that pose significant risks to human health. Modelling the exposure pathway from production to consumption is often adversely affected by substantial data gaps, and a particular problem lies in evaluating the impact of consumer food handling and cooking practices at the final step in the exposure pathway. Currently, relatively little human data are available to model dose-response curves, and independently validate risk estimates.

MRA is a new science and to date very few risk-based regulatory limits have been set on this basis.

RISK MANAGEMENT IN MEAT HYGIENE

Consideration of all available control options throughout the production-to-consumption continuum is the ideal scenario when managing meat-borne risks to human health. However, this may not be necessary or practical in cases where:

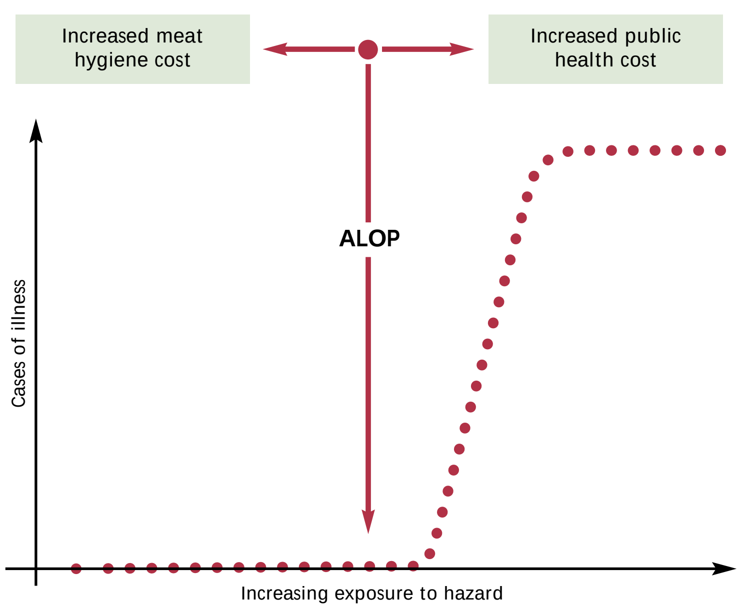
- available risk assessment models only cover a particular segment of the food chain;
- risk management objectives only relate to a particular step (or steps) in the food chain;
- different meat hygiene measures are being evaluated for equivalence.

The decision-making process

Although the decision-making process in risk management will be facilitated by the competent authority, specific mechanisms should be in place to include the expert advice and opinions of other stakeholders, particularly industry and consumers.

Risk assessors are likely to have examined the impact of different measures on minimizing food-borne risks, thereby providing risk managers with data that help them reach decisions on the optimal way to achieve the agreed level of consumer protection.

FIGURE 1.4 **Reaching a decision on an appropriate level of protection (ALOP) in meat hygiene**



Source: S. Hathaway, New Zealand Food Safety Authority.

Decisions on managing meat-borne risks should take into account, where appropriate, other factors that can be legitimately considered within a particular risk management framework, e.g. cost and practicality of proposed measures (Figure 1.4). In some cases, an ALOP may be reflected in the meat hygiene measures currently in place, and no further interventions are needed.

International considerations

In international fora such as the Codex Alimentarius committees, economic consequences and the technological feasibility of different measures may be considered when elaborating meat hygiene standards as benchmarks for international trade. Industry, consumers and other stakeholders can have their views represented through their national delegations.

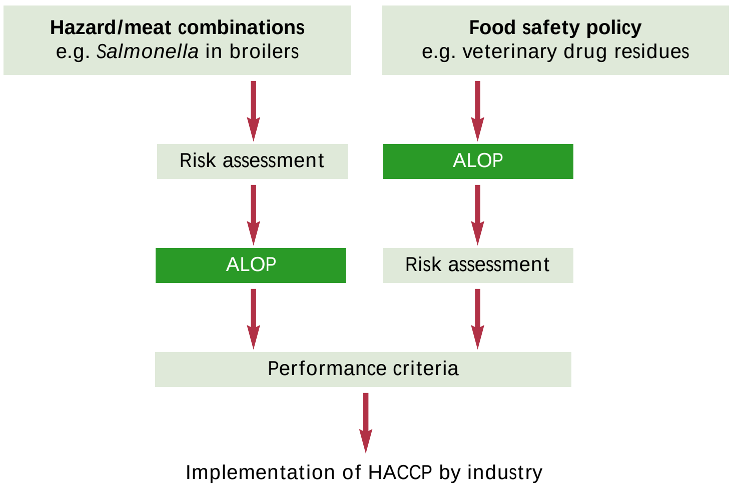
In addition to differences in choice of ALOP between countries, differences often occur in food production systems, technological capacity and food safety measures themselves. Such situations illustrate the importance of the concept of equivalence. If risk assessment can demonstrate that different practices in different countries can still result in the same level of consumer protection, there should be no impediment to international trade in the food concerned.

Application of a risk-based approach to demonstrate equivalence facilitates much greater flexibility in the use of new or alternative meat hygiene tests, procedures and technologies. If new or alternative measures that are more efficient or cost-effective can be shown to be as effective as existing measures, i.e. equivalent, industry can take advantage of all the gains available.

PRACTICAL APPLICATION OF RISK MANAGEMENT PRINCIPLES TO THE MEAT SECTOR

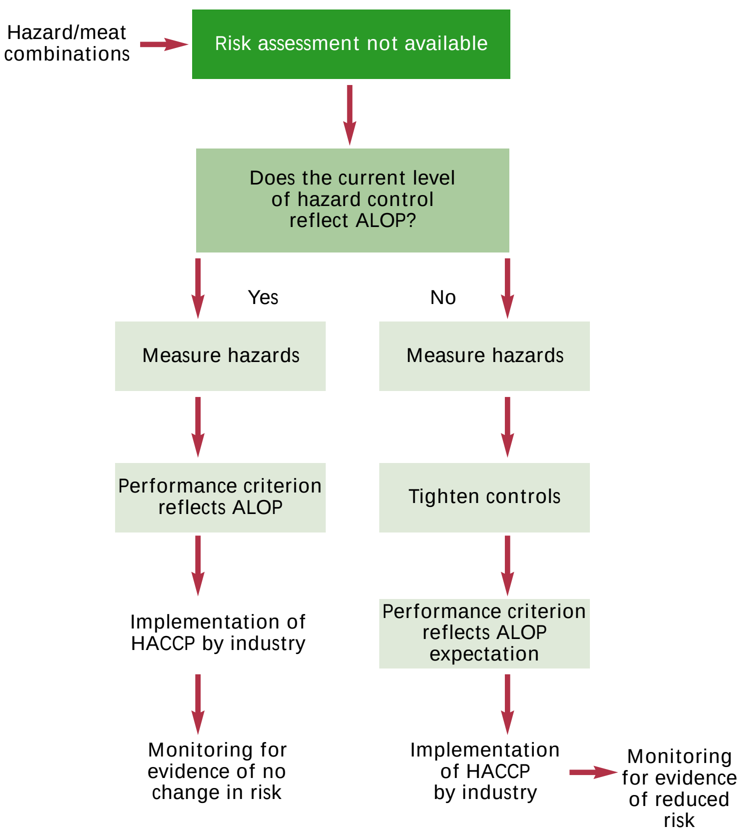
Despite the resource-intensive nature of meat hygiene programmes, assessment of their overall benefit is still limited by the lack of systematic data on the various elements of meat hygiene as they relate to public health. Application of risk management principles should gradually improve this situation, particularly in the area of process control.

FIGURE 1.5 **Pathway for establishment of risk-based performance criteria**



Source: S. Hathaway, New Zealand Food Safety Authority.

FIGURE 1.6 **Alternative pathways for establishment of risk-based performance criteria**



Source: S. Hathaway, New Zealand Food Safety Authority.

Stakeholder involvement

Application of risk management principles in the meat sector will involve all stakeholder groups in one way or another. The competent authority will facilitate application of all components of the generic framework for managing risks, set risk-based regulatory requirements as appropriate and verify that these are being met on an ongoing basis. The primary involvement of industry will be in contributing to risk management decisions, implementing meat hygiene programmes and ensuring compliance with regulatory requirements.

Risk management outcomes

Systematic application of a generic framework for managing meat-borne risks to human health can take several forms, depending on whether or not a detailed risk assessment is available. Risk management decisions can be based on:

- quantitative estimates of risk reduction;
- qualitative estimates of risk reduction;
- precautionary approaches.

The practical outcome of its impacts on the meat industry may be:

- accept current meat hygiene controls;
- set a risk-based regulatory limit for a particular hazard/meat product combination so as to provide a particular level of protection (Figure 1.5);
- prescribe a regulatory measure other than a regulatory limit that is likely to provide a particular level of protection;
- remove a regulatory measure that has been shown to have negligible impact on minimizing risk;
- set a provisional regulatory measure reflecting a precautionary approach (Figure 1.6);
- effect the implementation of risk-based measures by industry as part of their own meat hygiene programme.

PROGRESS TO DATE

To date, application of risk analysis principles has primarily focused on primary production and process control activities (the latter includes ante- and post-mortem inspection). Simulation modelling of risk management interventions in these areas is available for some hazard/product combinations, but examples of regulatory uptake of outcomes are rare.

"Through-chain" modelling has resulted in a number of recommendations on regulatory measures, based on qualitative estimates of likely risk reductions. In the absence of regulatory uptake, industry can implement such measures of its own accord.

Several competent authorities have removed resource-intensive post-mortem inspection procedures where they have been shown to be of negligible benefit.

In the absence of robust risk assessment, precautionary measures have been established for particular hazards in some cases, e.g. surveillance and prevention of BSE.

APPLICATION OF RISK ANALYSIS PRINCIPLES TO PRIMARY PRODUCTION

Primary production is a major source of meat-borne hazards. Risk assessment utilizing a production-to-consumption approach is likely to illustrate the importance of hygiene activities at this level, but few examples of quantitative modelling are currently available.

Risk management based on quantitative estimates of risk

A risk model may demonstrate that application of a particular measure at primary production will have a significant impact on achieving an ALOP. Where difficulty in verification by a competent authority acts against setting of risk-based regulatory requirements, an industry-led quality assurance programme can be a useful vehicle for voluntary implementation.

Chemical hazards

In general terms, the "safety evaluation" process for chemical hazards in foods utilizes a "notional zero risk" approach and good agricultural practice (GAP)/good veterinary practice (GVP) at the farm level to ensure that residue levels in meat do not exceed the ADI. Monitoring of meat for compliance with MRLs, MPLs, etc., over time, provides verification that the ADI is not exceeded. This is a good practical example of risk management in action. Although the safety evaluation process for chemical hazards can be criticized as an uncertain risk assessment process, the measures that result (GAP and GVP) are intended to deliver a specified ("notional zero risk") level of consumer protection.

Risk management measures for chemical hazards at the level of primary production include marketing authorization, legislation on the delivery and issue of veterinary drugs and agrochemicals, and surveillance or control plans for animals and meat, and come within the competence of the authorities. Some aspects of GAP and GVP in relation to these measures may be verified by the competent authority, e.g. maintaining lists of animal treatments, but industry-led quality assurance schemes are more common vehicles for verification.

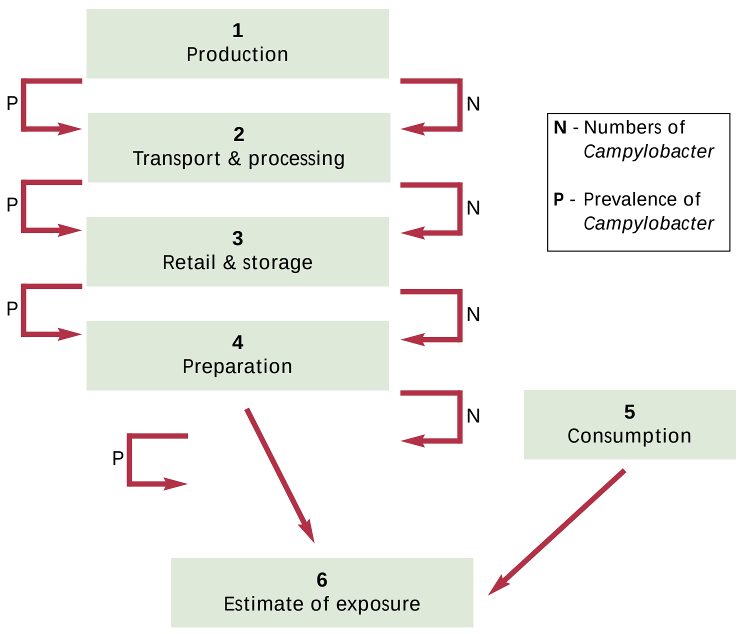
Biological hazards

An international FAO/WHO risk assessment of *Campylobacter* spp. in broiler chickens used modular modelling of the production-to-consumption food pathway to estimate risks to consumers, and to evaluate the impact of different interventions in each module (FAO/WHO, 2003c) (Figure 1.7). A reduction in flock prevalence had a proportional impact in reducing consumer risk and this indicates that any risk management programme that significantly reduces flock prevalence will be of measurable benefit to consumers. The challenge from this work is for regulators to facilitate risk management decisions on an ALOP, and for industry to find practical and cost-effective ways to implement optimal interventions. The model was constructed so that different countries could provide their own inputs and generate appropriate estimates of risk to their own consumers.

In the FAO/WHO risk assessment of *Campylobacter* spp. in broiler chickens, exposure assessment investigated possible pathways for contamination of chickens on the farm, and followed chickens through the various modules of rearing, transport, processing, storage, and preparation and consumption in the home. The level of hazard on the carcass at the end of processing was found to be a composite of *Campylobacter* spp. in the gut of colonized birds and the degree of exterior contamination pre-slaughter.

At the farm level, the effects of between-flock prevalence and within-flock prevalence on risks to consumers were modelled. As very high rates

FIGURE 1.7 **Exposure pathway for risk modelling of *Campylobacter* in broiler chickens**



Source: S. Hathaway, New Zealand Food Safety Authority.

of colonization occur following introduction of the hazard to a flock, avoiding initial contamination is a key mitigation strategy. It was found that reduction in flock prevalence had a proportional impact on reducing consumer risk.

A FAO/WHO risk assessment of *Salmonella* in broiler chickens (FAO/WHO, 2002a) estimated that any measure that sustainably reduced the level of contamination prior to the end of processing would proportionately reduce human illness. This suggests that hygiene measures implemented by industry at primary production level would have significant risk management value. Data inputs were only available from a small number of countries, and it was recommended that individual countries use their own data sets when applying the model.

The FAO/WHO risk assessment of *Salmonella* in broiler chickens characterized the probability of illness in a year owing to the ingestion of *Salmonella* on carcasses that are cooked in domestic kitchens. The model commenced at the end of slaughterhouse processing and included home handling and cooking. Risk estimates were generated for direct (cooked chicken) and indirect (cross-contamination in the kitchen) exposure pathways.

Inability to model the primary production and processing segments of the food chain meant that the impact of individual measures that reduced levels of *Salmonella* during these segments could not be quantitatively linked to changes in risks to consumers. Despite this, a one-to-one relationship was estimated between reduction in levels of contamination of carcasses at the end of processing and reduction in risk to consumers. This indicated that any measure that sustainably reduced the level of contamination prior to the end of processing would proportionately reduce human illness.

The Poultry Food Assess Risk Model developed by the United States Department of Agriculture (USDA) (Oscar, 1999) is a user-friendly tool for prediction of *Campylobacter* and *Salmonella* risks resulting from specified production-to-consumption scenarios. Baseline model settings are provided, and different production and processing scenarios can be modelled by the operator. Additionally, high-susceptibility human populations can be specifically assessed for poultry-borne risks. It is envisaged that this tool will be used by competent authorities and industry to make risk management decisions that could substantially reduce food-borne risks from poultry.

The Poultry FARM Model was used to simulate the use of competitive exclusion technology in the hatchery. The model predicted that there would be a reduction in contamination at the processing plant exit from 20 percent to 8 percent for *Salmonella*, and a reduction in consumer exposure of approximately one-third. This translated into a significant reduction in risks to consumers. In contrast, competitive exclusion technology would not result in any reduction in risks owing to *Campylobacter.*

A quantitative production-to-consumption risk assessment model for Shiga toxin-producing *E. coli* (STEC) O157 was prepared for steak tartare patties (Nauta *et al*., 2001), typically eaten raw or partially raw in Europe. Modelling of the exposure pathway indicated that about 0.3 percent of raw patties were contaminated at the time of consumption, and most of these had only 1 cfu of the pathogen. Although limited data availability rendered the final risk estimate uncertain, the model indicates that reducing infection at the farm level will have a significant impact on reducing risks to consumers.

Risk management based on qualitative estimates of risk

It is well established that general attention to livestock management, environmental hygiene and transport will limit the numbers of live animals shedding and being contaminated with enteric pathogens such as *Salmonella, Campylobacter* and *E. coli* O157:H7. This can result in a commensurate decrease in pathogen numbers on dressed carcasses. A number of studies have now shown that minimizing the level of inadvertent microbiological contamination with enteric pathogens during processing will reduce meat-borne risks in most situations. A number of interventions have now been recommended on a qualitative understanding that they will reduce food-borne risks.

A range of risk management strategies for reducing risks from *Salmonella* in poultry have been suggested by the Codex Committee on Food Hygiene (CCFH). These include strict quarantine measures to keep breeder flocks free of *Salmonella*, use of probiotics, vaccination and withholding of feed prior to transport to slaughter. The relative value of each intervention is unknown.

The Food Safety and Inspection Service of the United States Department of Agriculture (FSIS USDA) has published guidance on minimizing risks due to *Salmonella* and *E. coli* O157:H7 in red meat, based on the qualitative understanding that reducing carcass contamination is an important risk management goal (FSIS USDA, 2002). A production-to-consumption approach is recommended with interventions in all segments of the food chain. FSIS expects industry to implement HACCP plans for process control that include stricter purchase specifications, more rigorous intervention methods, or a higher frequency of verification. At the production level, FSIS expects slaughter establishments to obtain cattle from farms or feedlots that employ production systems or feedlot controls shown to reduce carriage rates of *Salmonella* and *E. coli* O157:H7.

Risk management measures recommended for *E. coli* O157:H7 by competent authorities in several countries include:

- dietary and feeding practices;
- minimizing faecal contamination of drinking-water;
- probiotics and competitive exclusion bacteria;
- innovative vaccines;
- "Farm Waste Management Plans";
- farmer education.

Risk management based on precautionary approaches

Application of risk management principles by competent authorities may lead to provisional regulatory measures being imposed on a precautionary basis at the level of primary production.

The World Organisation for Animal Health (OIE) International Animal Health Code chapter on BSE provides a good example. A broad range of measures can be applied to animals and animal products in international trade, and many of these are precautionary in nature rather than being determined by quantitative risk modelling. The extent of measures that are required at the national level will depend on the BSE categorization of the country or zone. The extent of the ongoing monitoring and surveillance system for BSE also results from a "risk analysis" of the BSE status of the country or zone.

GHP that facilitates risk management

Aspects of GHP at primary production that facilitate a risk-based approach to meat hygiene include:

- animal identification and trace-back;
- integrated flow of information on hazards;
- official or officially recognized programmes for monitoring of zoonotic hazards;
- specific controls on animal feedstuffs where there is a likelihood of transmission of zoonotic agents.

APPLICATION OF RISK MANAGEMENT PRINCIPLES TO PROCESS CONTROL

Many aspects of slaughter and dressing procedures have the potential to result in significant contamination of meat, e.g. hide/feather removal, evisceration, carcass washing, post-mortem examination, trimming and further handling in the cold chain. Systems for process control should limit microbial cross-contamination and growth in these circumstances to as low as practicably achievable, and reflect the proportional contribution of these controls in reducing meat-borne risks to human health.

Microbiological monitoring at specific points in the food chain is increasing in importance as a tool for ensuring a risk-based approach to food safety. Specification of risk-based regulatory limits ensures that required levels of consumer protection are achieved, while providing maximum flexibility to industry in terms of the detail of the process control systems that they employ.

Risk management based on quantitative estimates of risk

Chemical hazards

Routine monitoring and surveillance for chemicals, contaminants and residues in meat constitute important risk-based elements of process control. In most situations, these will be the responsibility of the competent authority rather than industry. Monitoring generally will be part of national rather than establishment-specific programmes. The competent authority should apply risk analysis principles in both the design of monitoring programmes and the response to non-complying tests.

Biological hazards

The FAO/WHO risk assessment of *Salmonella* in broiler chickens (FAO, 2002a) estimated that a percentage change in contamination of chickens at the end of processing would result in the same percentage change in risks to consumers. Individual aspects of process control were not modelled, but any intervention that significantly and sustainably reduced levels of *Salmonella* contamination prior to the end of processing would be expected to be an effective risk management measure.

In the FAO/WHO risk assessment of *Campylobacter* spp. in broiler chickens (FAO/WHO, 2003c), relative reductions in risk as a result of different risk management interventions during processing were estimated. The washing-off effect of water chilling was estimated to result in lower risks to consumers compared with those generated from air-chilled chickens, but there was uncertainty around the effect of cross-contamination in chill water. Industry would not be expected to respond to such predictions until high levels of uncertainty can be removed from the model outputs.

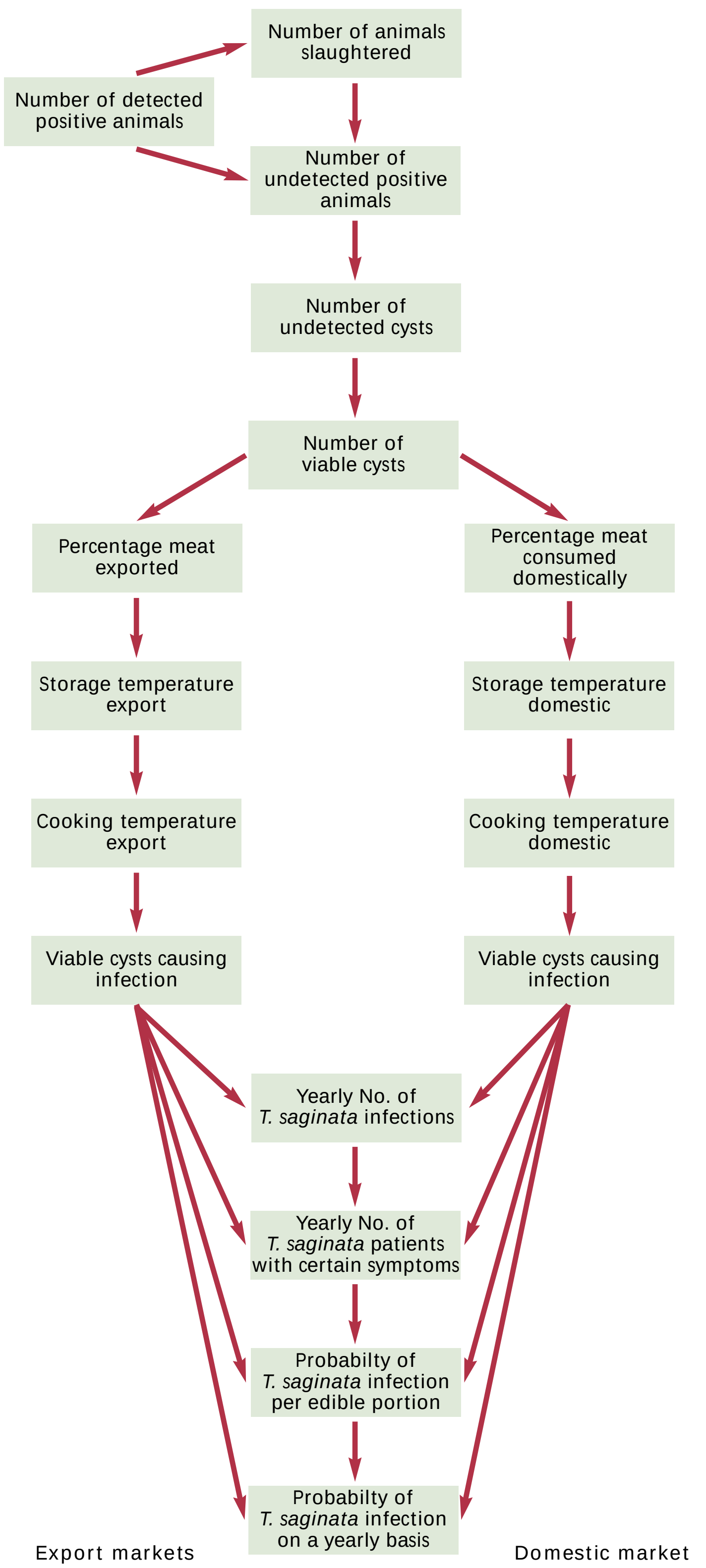
The Poultry FARM model developed by USDA (Oscar, 1999) is a user-friendly tool for prediction of *Campylobacter* and *Salmonella* risks resulting from specified production-to-consumption scenarios. This includes the opportunity to model different process control interventions. In a generic context, simulation of the impact of defined levels of contamination of poultry at the end of processing with subsequent risks to consumers can provide a quantitative basis for risk management decisions.

Modelling of *E. coli* O157:H7 in ground beef hamburgers was used to evaluate three hypothetical intervention strategies (Cassin *et al.*, 1998). A simulated reduction in temperature during retail storage resulted in an 80 percent reduction in the risk estimate and this was much more effective than a risk management measure aimed at educating consumers to cook their hamburgers more thoroughly (predicted reduction of 16 percent). Owing to limited data inputs, further work is needed on modelling this particular hazard/meat product pathway.

A risk assessment model for STEC O157 in steak tartare patties (Nauta *et al.*, 2001) indicates that reducing cross-contamination during process control will have a significant impact on reducing risks to consumers. Specific methods for achieving this were not evaluated in the model.

A draft international risk assessment of *Listeria monocytogenes* in ready-to-eat foods (FAO/WHO, 2002b) estimated risks associated with consumption of fermented meats as a generic food class. The traditional process does not have a lethal processing step, and moderate contamination exists at retail. However, lack of growth and inactivation of existing organisms during storage render risks extremely low compared with other classes of foods, e.g. smoked fish and milk. The risk model demonstrated that almost all cases of food-borne listeriosis result from ingestion of high numbers of pathogens, and existing regulatory standards of zero tolerance or 100 cfu/g could barely be separated in terms of their impact on reducing risks. Adoption of the higher level as a risk-based regulatory limit would facilitate a more targeted risk management response to this food-borne problem, and allow flexibility in terms of the specific interventions employed by industry.

FIGURE 1.8 **Risk model for *Taenia saginata* (human beef tapeworm) in cattle**



Source: S. Hathaway, New Zealand Food Safety Authority.

An important practical outcome of this risk assessment for industry is the need to demonstrate that a particular meat product is stabilized against the growth of *Listeria*. Repeated shelf-life studies at appropriate temperatures may be needed to verify that low levels of *Listeria* at the end of processing will not increase during retail and storage segments of the food chain. Industry would have a choice of the risk management measures it employs to achieve a FSO of less than 100 cfu/g at the time of consumption.

Post-mortem inspection

Post-mortem meat inspection procedures are a unique set of hygiene measures that are part of process control. Traditional inspection procedures are complex and resource-intensive, and a number of recent studies have used a risk assessment approach to determine their relative value in minimizing meat-borne risks. These studies are carried out by competent authorities and scientific institutions rather than industry. A risk-based post-mortem meat inspection programme that is tailored to the particular type and geographical origin of slaughtered animals should achieve essentially the same level of consumer protection as a traditional programme.

Practical outcomes for industry include: organoleptic inspection procedures that are cost-effective and proportional to risk reduction; judgement of the equivalence of different measures; more practical requirements for presentation of tissues by industry; and integration of post-mortem meat inspection into a production-to-consumption system for minimizing risks. Principles and guidelines for developing risk-based post-mortem inspection procedures are provided in an annex to the Codex proposed *Draft code of hygienic practice for meat* (FAO/WHO, 2004).

A risk assessment model has been used to investigate the value of traditional post-mortem inspection of cattle for cysts of the beef cestode *Taenia saginata* in New Zealand (Van der Logt, Hathaway and Vose, 1997) (Figure 1.8). These procedures have very low sensitivity in detecting cysts in regions where infection is rare, and the risk model demonstrated that post-mortem inspection has virtually no effect on decreasing the already extremely low risks to human health in the New Zealand situation. As a consequence, routine incision of the cheeks and tongues of cattle is no longer a regulatory requirement and this markedly reduces head inspection costs and allows meat hygiene activities to be focused elsewhere. If industry does not wish to recover cheek meats, head skinning can be avoided.

Risk management based on qualitative estimates of risk

Biological hazards

FSIS USDA guidance on minimizing risks due to *Salmonella* and *E. coli* O157:H7 (FSIS USDA, 2002) is strongly focused on interventions during process control that minimize carcass contamination. While advocating a production-to-consumption approach, risk management interventions are based to a large extent on hygiene procedures and intervention methods that prevent carcass contamination during dehiding and later process steps. A zero-tolerance for visible faecal contamination is a regulatory requirement that must be achieved by industry, and slaughter premises are expected to include at least one HACCP-based intervention specifically targeted to reduce risks due to *Salmonella* and *E. coli* O157:H7. Innovative risk management options such as hot water and acid washes, steam vacuuming and steam pasteurization are encouraged, and their effectiveness either alone or in combination needs to be validated by industry. Regulatory monitoring limits based on performance criteria are set to ensure adequate process control.

TABLE 1.1 **Risk-based post-mortem inspection procedures for the heads of adult cattle slaughtered in New Zealand**

Tissue	Traditional	Risk-based
External surfaces/oral cavity	V	-
Eyes	V	V
Tongue	V, I	V, P*
Submaxillary lymph nodes	V, I	I
Parotid lymph nodes	V, I	I
Retropharyngeal lymph nodes	V, I	I
Muscles of mastication	V, P, I**	V, P*

V View
P Palpate
I Incise
* Only if intended for human consumption
** Incised according to the potential for infestation with cysts of *Taenia* spp.

Risk management strategies suggested by the CCFH for reducing risks from *Salmonella* in poultry include channelling of meat from infected flocks for heat treatment, decontamination of carcasses and microbiological monitoring. However, current risk models are insufficient to determine the relative value of such measures.

Minimizing contamination with *Campylobacter* is an important part of process control to minimize meat-borne risks according to a qualitative risk management approach. Given that risk models have demonstrated strong correlations between levels of carcass contamination and subsequent risks to consumers, several countries have initiated evidence-based standard operating procedures to prevent or minimize contamination during process control (Food Safety Authority of Ireland, 2002). It is interesting to note that risk management interventions such as irradiation and chemical disinfection may be acceptable to consumers in some countries but not in others.

Post-mortem inspection

Competent authorities in several countries have used qualitative risk-based approaches based on comparisons of hazard control to evaluate traditional post-mortem inspection procedures. Outcomes that have been translated into changes in regulatory requirements include hands-off carcass inspection for lambs in the United States of America, streamlined inspection of prime cattle in Canada, and visual inspection of the viscera of fattened pigs in Australia. A detailed example of risk-based changes in head inspection procedures for all hazards in cattle in New Zealand is given in Table 1.1.

Risk management based on precautionary approaches

Precautionary risk management measures may be imposed by competent authorities as a component of process control, e.g. routine condemnation of specified risk materials and prohibition of mechanically recovered meat, in regions where BSE is present in slaughter populations. These measures may result in considerable costs to industry, and should be regarded as provisional until more science-based measures can be developed.

GHP that facilitates risk management

Many aspects of GHP during process control facilitate a risk-based approach to meat hygiene. The most important of these include:

- hygiene measures that minimize cross-contamination of the carcass during dehiding/defeathering, etc. and subsequent dressing procedures;
- HACCP plans for control of specific hazards;
- product identification and trace-back;
- integrated flow of information on hazards to other segments of the food chain.

APPLICATION OF RISK MANAGEMENT PRINCIPLES TO PRODUCT INFORMATION AND CONSUMER AWARENESS

Risk management based on quantitative estimates of risk

A risk assessment model for *E. coli* O157 for steak tartare patties (Nauta *et al.*, 2001) indicated that while reducing infection at the farm level and minimizing cross-contamination during processing, advocating the consumption of well done steak tartare patties is not likely to reduce risks significantly.

The Poultry FARM Model developed by USDA (Oscar, 1999) was used to simulate the impact of improved consumer food practice in the home on reducing *Campylobacter* and *Salmonella* risks. A simulated reduction to 5 percent for rates of temperature abuse, incidence of undercooking and incidence of recontamination of poultry in the home resulted in marked reductions in estimates of risks.

A Food Handling Practices Model developed for the United States Food and Drug Administration Center for Food Safety and Applied Nutrition (FDA/CFSAN) provides a generic quantitative risk assessment tool to estimate the effects of food handling practices on the incidence of food-borne illness (RTI International, 2001). The model can be used for meat as well as a number of other food categories. The impact of retail and household practices on microbiological contamination can be combined with food-source levels of contamination to generate estimates of risk.

Risk management based on qualitative estimates of risk

Risk models for several enteric pathogens indicate that cross-contamination from the raw meat product to other foods in the home is a significant pathway for meat-borne risks to human health. Risk management interventions to avoid this are commonly recommended by competent authorities.

GHP that facilitates risk management

Aspects of GHP that facilitate a risk-based approach to meat hygiene in the home include:

- consumer education in safe food handling practices;
- avoidance of cross-contamination;
- labelling.

Summary

- A risk-based approach to food hygiene has been instituted by both national governments and standard-setting bodies for food in international trade largely as a consequence of the international trade provisions of the WTO SPS Agreement, and in fulfilment of their obligation to justify necessary food hygiene measures using science and risk assessment.
- The practical application of a risk-based approach in meat hygiene requires an understanding of:
  - The building blocks of a meat hygiene programme (GHP, HACCP and risk assessment):
    - GHP generally consists of a qualitative description of all practices regarding the conditions and measures necessary to ensure the safety and suitability of food requirements. The requirements are generally prescriptive and describe processes rather than outcomes.
    - HACCP identifies, evaluates and controls hazards that are significant for food safety. The system has designated CCPs at particular steps in the food chain, which may be based on empirical scientific judgement, or on risk assessment.
    - A risk assessment programme entails knowledge of the level of control of hazards that is attained at a particular step in the food chain relative to the expected level of consumer protection. The control points are science- and risk-based regulatory limits, which may either be performance criteria (e.g. allowable levels of microbial contamination, MRLs, zero tolerance for TSEs) or process criteria (e.g. specified time, temperature or dose at a specified process control step).
  - Application of a risk management framework, which includes:
    - preliminary risk management activities: risk profiling, risk assessment policy formulation, risk assessment;
    - evaluation of risk management options: reaching a decision on an ALOP in order to minimize risks using available meat hygiene measures. The meat hygiene measures selected for implementation are determined through risk assessment;
    - implementation of meat hygiene measures: by means of a tailor-made programme based on GHP, or one or more CCPs (HACCP), or regulatory limits or procedures derived from risk assessment;
    - monitoring and review: gathering and analysing data on human health so as to give an overview of food safety and consumer health.
  - Risk assessment: a separate and distinct scientific process commissioned by government in most cases and carried out by national science providers. It involves the four steps of:
    - **hazard identification:** the identification of biological, chemical and physical agents in food capable of causing adverse human health effects;
    - **hazard characterization:** the qualitative or quantitative evaluation of the nature of the adverse health effects, ideally including human dose-response assessment;
    - **exposure assessment:** the qualitative or quantitative evaluation of the likely intake of food-borne hazards by consumers, taking into account other hazard exposure pathways where relevant;
    - **risk characterization:** the qualitative or quantitative estimation, including attendant uncertainties, of the probability of occurrence and severity of adverse health effects in a given population.
  - Risk management: decision-making on managing meat-borne risks in an optimal way to achieve the agreed level of consumer protection. The decisions are based on data generated by risk assessors on the impact of different measures on minimizing food-borne risks.
  - The different roles of industry, government and other stakeholders in the design and implementation of a meat hygiene programme, e.g.
    - The competent authority should facilitate application of all components of the generic framework for managing risks, set risk-based regulatory requirements as appropriate, and verify that these are being met on an ongoing basis.

- The industry should be involved in contributing to risk management decisions, implementing meat hygiene programmes and ensuring compliance with regulatory requirements.

- Despite the resource-intensive nature of meat hygiene programmes, assessment of their overall benefit is still limited by the lack of systematic data on the various elements of meat hygiene as they relate to public health.
- To date, application of risk management principles in the meat industry has primarily focused on primary production and process control (including ante- and post-mortem inspection) activities. Simulation modelling of risk management interventions in these areas is available for some hazard/product combinations (e.g. *Campylobacter* and *Salmonella* risk assessment models for broiler chickens; models for *E. coli* species in beef products; and *Listeria monocytogenes* in ready-to-eat foods) but examples of regulatory uptake of outcomes are rare. The limited application of risk assessment models to other areas of meat hygiene to date means that few recommendations on risk-based interventions are available for these activities.
- The Codex proposed *Draft code of hygienic practice for meat* presents through-chain guidelines for meat hygiene, up to the point of retail. These generic guidelines are based on GHP, and risk-based concepts are introduced wherever appropriate. The guidelines stress that any risk-based measures that are employed should be matched to the local or national situation.

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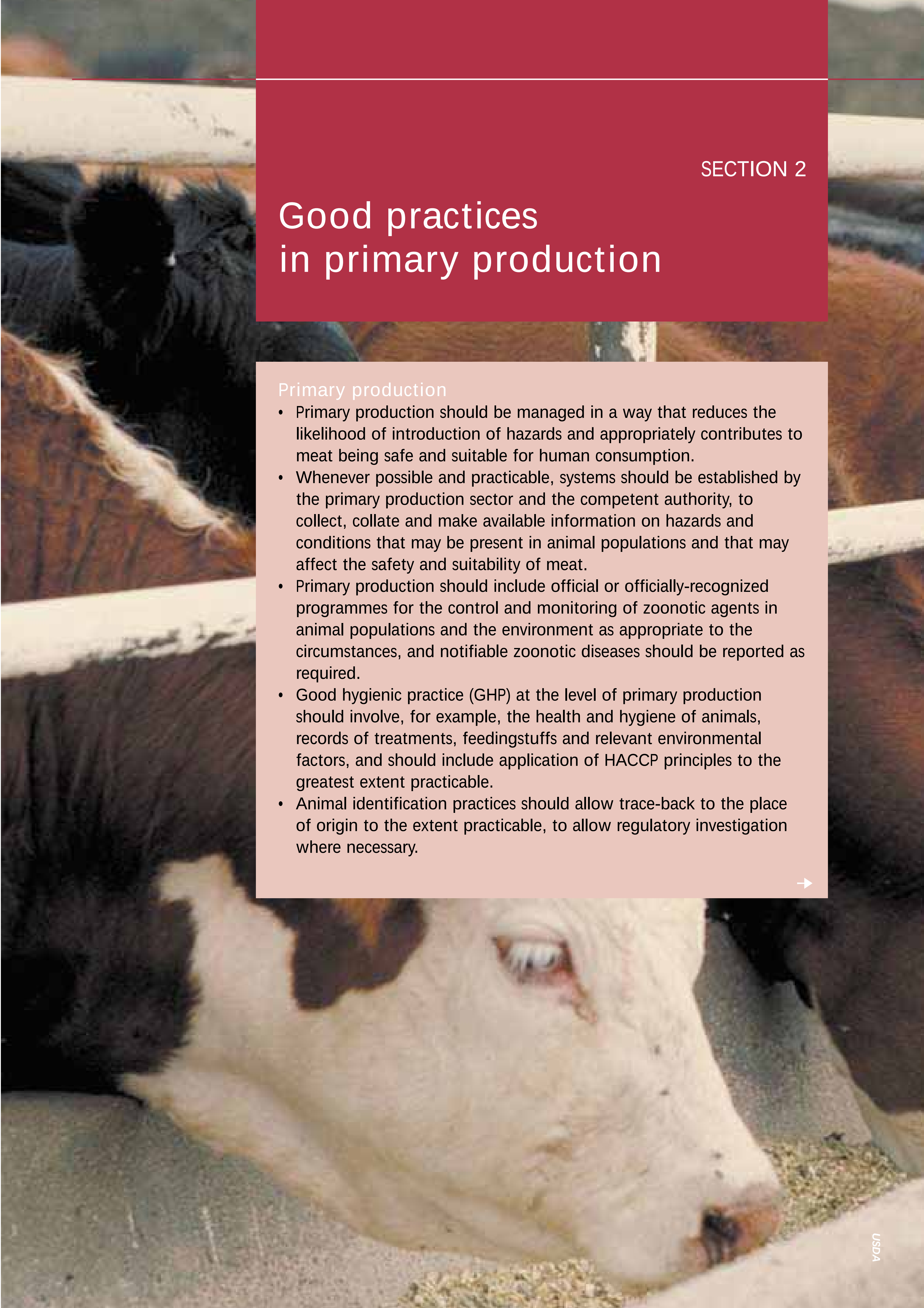
SECTION 2

Good practices in primary production

Primary production

- Primary production should be managed in a way that reduces the likelihood of introduction of hazards and appropriately contributes to meat being safe and suitable for human consumption.
- Whenever possible and practicable, systems should be established by the primary production sector and the competent authority, to collect, collate and make available information on hazards and conditions that may be present in animal populations and that may affect the safety and suitability of meat.
- Primary production should include official or officially-recognized programmes for the control and monitoring of zoonotic agents in animal populations and the environment as appropriate to the circumstances, and notifiable zoonotic diseases should be reported as required.
- Good hygienic practice (GHP) at the level of primary production should involve, for example, the health and hygiene of animals, records of treatments, feedingstuffs and relevant environmental factors, and should include application of HACCP principles to the greatest extent practicable.
- Animal identification practices should allow trace-back to the place of origin to the extent practicable, to allow regulatory investigation where necessary.



USDA

Hygiene of feedingstuffs

Animals should not be fed feedingstuffs that:

- are recognized as likely to introduce zoonotic agents (including TSEs) to the slaughter population; or
- contain chemical substances (e.g. veterinary drugs, pesticides) or contaminants that could result in residues in meat at levels that make the product unsafe for human consumption.

Hygiene of the environment

The competent authority should design and administer monitoring and surveillance programmes appropriate to the circumstances, that:

- address hazards arising from animals and plants that may compromise the production of meat that is safe and suitable for human consumption;
- address environmental contaminants that may result in levels in meat that make the product unsafe for human consumption; and
- ensure that water and other potential carriers, e.g. fertilizer, are not significant vehicles for transmission of hazards.

Facilities and procedures should be in place to ensure that:

- housing and feeding platforms where used, and other areas where zoonotic agents and other hazards may accumulate, can be effectively cleaned, and are maintained in a sanitary condition;
- systems for active processing and/or disposal of dead animals and waste should not constitute a possible source of food-borne hazards to human and animal health; and
- chemical hazards required for technological reasons are stored in a manner so that they do not contaminate the environment or feedingstuffs.

Source: FAO/WHO, 2004.

INTRODUCTION

The number of food-borne diseases is growing rapidly, and the safety level expected by consumers has not yet been attained. Continuation of the problem has been well illustrated in recent years by human surveillance studies of specific meat-borne pathogens such as *Escherichia coli* O157:H7, *Salmonella* spp., *Campylobacter* spp. and *Yersinia enterocolitica*; the emergence of new hazards, such as the agent of bovine spongiform encephalopathy (BSE); and recurring disease outbreaks that have led to wholesale destruction of livestock (e.g. the 2001 food-and-mouth disease [FMD] outbreak in the United Kingdom of Great Britain and Northern Ireland (UK) and the 2003/2004 avian influenza outbreak in Eastern Asia).

Consequently, consumers are increasingly looking for products that are not only safe and healthy, but also morally acceptable. Assuring food safety throughout every part of the food chain has thus become a vital priority for the meat industry. This has prompted a rise in national and industry-led regulations aimed at improving food safety, animal production and animal welfare.

International standards for meat safety, which are intended to be the preferred choice of sanitary measures, are elaborated in various documents of the Codex Alimentarius Commission (Codex) and the World Organisation for Animal Health (OIE) (e.g. FAO/WHO, 2004; OIE, 2003a, 2003b). These standards are based on risk-based approaches, founded on good hygienic practice (GHP), Hazard Analysis and Critical Control Points (HACCP) and, ultimately, risk assessment (see Section 1).

The premise of GHP in meat production is that meat should not contain any pathogens or traces of growth promoters, veterinary drugs, pesticides or environmental contaminants in quantities that could compromise or damage consumer health. The role of livestock farmers in this is to ensure that good practices are employed at the farm level to avert the risk of contamination of the meat animals. Such practices are essential to underpin the application of HACCP systems and, in advanced systems, risk assessment and management strategies.

Both primary producers and competent authorities should work together to implement risk-based meat hygiene programmes at the level of primary production. The programmes should document the general status of slaughter animals and implement practices that maintain or improve that status, and include zoonoses control programmes. National and industry-led quality assurance (QA) programmes (e.g. Assured British Meat, Meat Standards Australia, Farm Assured Namibian Meat) at the level of primary production should be encouraged and may include application of HACCP principles as appropriate to the circumstances.

The aim of this section of the manual is to set some basic guidelines for the application of generic GHP practices to primary meat livestock production. The guidelines are based on the *Recommended international code of practice: general principles of food hygiene* (FAO/WHO, 1999) and the Codex proposed *Draft code of hygienic practice for meat* (FAO/WHO, 2004). Although the focus is on good practices for producing clean meat, cognizance of the broader good agricultural practice (GAP) is taken throughout since GAP emphasizes the important ethical production practices related to animal welfare, environmental protection and labour management. For each area of livestock management in primary production, the general GAP principles are discussed and guidelines pertinent to clean meat production (GHP) are highlighted in tabular form.

The philosophy here has not been to create elaborate and detailed standards (e.g. chemical quality of drinking-water or acceptable bacterial counts in feed) but to outline common sense practices that are easy to implement. Where finding an applicable local standard may present problems, the use of specific expert guidance is advised.

PRINCIPLES AND RECOMMENDED PRACTICES AT FARM LEVEL

Guiding principle

Meat should be produced from healthy animals under generally accepted conditions. To achieve this, good and hygienic production practices should be implemented at the level of primary production so as to reduce the likelihood of introducing hazards and to contribute appropriately to meat being safe and suitable for human consumption.

Basic animal welfare

Concern for animal welfare is not based only on the satisfaction of human ethical needs, but also has to do with productivity. Animals that are stressed, experiencing pain or discomfort, or inadequately fed or watered will not produce to their full potential. It is therefore essential that basic welfare requirements be met. Good animal welfare is recognized as freedom from hunger and thirst; freedom from discomfort; freedom from pain, injury or disease; freedom to express normal behaviour; and freedom from fear and distress.

Basic animal welfare needs are:

- an adequate quantity and quality of water, food and air to maintain good health and production;
- social contact with other animals;
- sufficient space to stand, lie down, stretch, groom and perform normal patterns of behaviour – including movement and exercise (Photo 2.1);
- protection from disease and injury with access to appropriate treatment if they occur;
- protection from climatic extremes where possible.

Shelter and handling facilities

Shelter and handling facilities should be planned according to the size of the herd, expansion plans, cleaning and disinfection needs, disposal of animal excrement, the available materials and the availability of good quality water. The shelter and handling facilities plans should take into consideration existing legislation on animal welfare and conform with the relevant animal welfare freedoms from discomfort, pain, injury or disease, freedom to express normal behaviour, to have social contact with other animals and freedom from fear and distress. The design and use of shelter facilities for beef cattle should promote the health, well-being and good performance of animals at all stages of their lives. Shelter facilities should be provided for the purposes of comfort and protection and not for the purposes of intensification, and they should be kept clean. Accordingly, cattle shelters and handling facilities should be designed to ensure ease of handling and to prevent injury to animals (Photos 2.2 and 2.3). Isolation (except when required by veterinary treatment), cramping, tethering and other forms of movement restriction are not permissible.

The design and siting of shelters must take into consideration environmental protection concerns. There should be no physical features in the environment that cause recurring injuries to animals. All reasonable steps should be taken to protect animals from predators.

Risks/hazards associated with animal shelter that could compromise the cleanliness of meat are outlined in Table 2.1 along with recommendations on how the risks could be averted and on possible control points.

PHOTO 2.1
GOOD PRACTICE: ***sufficient space to stand, lie down, stretch, groom and perform normal patterns of behaviour - including movement and exercise***

M. BLEICH, SWITZERLAND

PHOTO 2.2
***Avoid*: injured animal on dirty floor with poor drainage: note the amputated tail and the swollen leg**

P. HEIMANN, FEDERAL VETERINARY OFFICE, BERNE, SWITZERLAND

Livestock feeding and watering

One of the basic animal welfare needs in order to maintain good health and production is for adequate quantity and quality of feed. Livestock should have access to a wholesome diet appropriate to their species, body age and condition so as to maintain optimal body condition (Box 2.1). Neonatal calves should receive colostrum for at least three days postpartum, and naturally suckled animals should have regular contact with their mothers. For older animals, the feed provided should take into account the age, sex and physiological status of the animals being fed. Expert advice must be actively sought in this respect. Where dictated by local conditions or needs (e.g. dry seasons), livestock should be given supplementary feed.

Animal feedingstuff should not contain chemical substances or contaminants (e.g. antibiotics, ionophores, hormones and other growth-promoting substances) that could result in residues in meat at a level that makes the

BOX 2.1 **How do I know that my cattle are well fed?**

Probably the most reliable means of determining an animal's nutritional level is to examine it with the intention of carrying out a body condition score. Condition scoring is normally done on a scale of 1 to 5, with 1 being the poorest and 5 being regarded as overly fat.

SCORE 1
Emaciated. Ribs and points of hips protrude, muscling obviously poor. Transverse processes of vertebrae sharp to touch.

SCORE 2
Thin. Ribs clearly visible, points of hips visible.

SCORE 3
Optimum condition. Ribs barely visible, points of hips well rounded, a clear "waistline" between last rib and pelvis. Ends of transverse processes can be felt with pressure.

SCORE 4
Fat. Ribs not visible, no "waistline" between ribs and pelvis.

SCORE 5
Overly fat, obese. As for score 4, but with palpable fat deposits unevenly distributed over pelvis area and under tailhead. Transverse processes cannot be felt.

Source: adapted from Defra, 2001.

M. BLEICH, SWITZERLAND

PHOTO 2.3
GOOD PRACTICE:
clean animals on well drained floor

TABLE 2.1. **Sheltering and handling facilities**

Risks/hazards and control points	Recommended practices	Suggested measures to achieve recommended practice
Risks • Injury from uneven and/or dirty, wet floors. • High microbial load on soiled skins. • Airborne infections. • Contamination of the animal feed and water by cleaning chemicals. • Buildup of infectious material in bedding. • Infectious organisms borne by pests (e.g. rodents and insects). **Control points** • Design, siting and construction of shelters and handling facilities. • Animal density in shelter and handling facilities. • Design, siting and construction of effluent management system and manure storage facilities.	• The living space provided to animals should be such that free movement and the expression of normal behaviour patterns are possible. • Handling facilities should be designed to ensure ease of handling and to prevent injury to animals. • Indoor shelter should have adequate ventilation. • Shelter facilities should be on mild slopes to prevent accumulation of water and prevent waterlogging. • Livestock buildings, manure and silos should be located in a way that minimizes their harmful influence on the environment; pollution of water sources by the slurry and manure should be prevented. • Slurry and manure should be frequently removed from the shelter facilities. • The volume of storage facilities should be large enough to store manure during the period when spreading is not allowed. • Shelter facilities should be maintained dry, clean and free from rodents and insects.	• Specifications related to farm installations and effluent management (official sanitary legislation) should be established by the competent authority and observed in the design, siting and construction of shelter, handling facilities and effluent management system. • There should be no physical features in the environment which cause recurring injuries to animals. • Facilities and procedures should be in place to ensure that shelter and feeding platforms, where used, and other areas where zoonotic agents and other hazards may accumulate can be effectively cleaned and maintained in sanitary condition. • Agricultural chemicals should be stored in such a manner that they do not contaminate the environment, water and feedingstuff. • Local guidelines for stored volumes of manure should be adhered to.

meat unsafe for human consumption. Feedingstuffs should be free of any material that is likely to introduce zoonotic agents to the meat (such as meat-and-bone meal, which could introduce the agent of bovine/transmissible spongiform encephalopathy [BSE/TSE], and poultry manure).

Where on-farm mixing of feedingstuffs is practised, good quality ingredients that are free of toxin-producing fungi and other contaminants should be used. Otherwise feedingstuffs should be procured from reputable, officially recognized manufacturers and distributors.

Livestock should always have access to clean drinking-water with no hazardous microbes and chemical contaminants. The drinking troughs should not have leaks in order to avoid wet floors and minimize the risk of transmitting foot-rot, parasitic and other disease conditions (Photo 2.4).

Risks/hazards associated with animal feeding and watering that could compromise the cleanliness of meat are outlined in Table 2.2

PHOTO 2.4
***Good practice:* livestock drinking clean water from a drinking trough (**Bos indicus** in north Senegal)**

FAO

along with recommendations on how the risks could be averted and on possible control points.

General livestock management practices

Livestock should not be unduly stressed during handling. Excessive use of electric goads (prods), whips and similar instruments is not permitted. These should be replaced as much as possible with alternative driving aids such as flags, plastic paddles and sticks with plastic ribbons attached (Grandin, 1993). Animals should not be harassed by dogs and, where necessary, dogs should be separated from livestock (except in the case of bona fide sheepdogs).

Livestock identification is essential in managing livestock. In the case of beef and dairy animals where a disease of concern to human health may emanate from a single animal, and would have to be traced back through the production chain to the single animal, the case for animal identification to the individual level is a strong one. It is thus necessary that farm animal management practices include systems for collection, collation and publishing of information on hazards and conditions that may be present in animal populations, which may affect the safety and suitability of meat for human consumption.

The identification of the animal must meet minimum standards concerning readability and tamper-resistance in order to be both reliable and credible. While the issue of livestock identification is fully dealt with elsewhere (see Section 3), the following basics apply:

- The means of identification should be easily

Box 2.2 **The use of livestock brands**

Hot branding has been in use for over 4 000 years. People have used branding to place their mark of ownership upon livestock. With reference to animals, branding has had the goal of identifying the owner rather than the animal - it is normally used to establish ownership, especially in cases of theft.

Branding suffers from all the disadvantages of both ancient technology and a lack of central control - it often lacks readability (as a result of poor construction of the branding iron, poor branding technique, intentional " blotching" by thieves, long winter coats on animals) and is regarded by many as a cruel practice.

Despite the shortcomings of branding and the fact that it can only be used to establish ownership, many have tried to use this obsolete technology for livestock identification. Proper identification of livestock has now been rendered possible by more modern methods.

As a means of livestock identification for management and traceability, branding must be regarded as unsuitable and outdated.

TABLE 2.2 Feeding and watering

Risks/hazards and control points	Recommended practices	Suggested measures to achieve recommended practice
	FEEDING	
Risks • Infection of animals by food-borne pathogens. • Inducing animals to shed pathogenic organisms into the evironment. • Animals ingesting harmful chemicals and substances which could accumulate in the meat. • High levels of undesirable residues in the meat. • Agent of BSE/TSE in feedingstuff. **Control points** • Source of feed ingredients, feedingstuffs and licks. • Storage of feed ingredients, feedingstuffs and licks.	• Animal should be provided with feedingstuffs, licks and/or supplements of good hygienic quality. • Changes in feeding regimes should be made gradually, particularly in the case of ruminants, so that digestive disturbances do not result.	• Animal feedingstuffs, licks and supplements should be produced in accordance with the code of good practices and stored in good conditions to ensure that they are free from contamination. . • Records should be kept of all feed ingredients, feedingstuffs and supplements fed to the animals. • An officially recognized traceability system for sources of feed ingredients, feedingstuffs, licks and supplements should be implemented by the primary production sector and controlled by the competent authority. • Limit use of antibiotics, ionophores, hormones and other growth-promoting substances to within legal and technical recommendations. • Feeds/licks/supplements should be protected from humidity, rodents and any other possible contaminants. • Ruminants should not be fed with any feedingstuff containing proteins originally derived from ruminants. Bone meal, carcass meal, meat-and-bone meal and poultry manure should be excluded from ruminant diets.
	PASTURES	
Risks • Microbial and parasitic infections from unclean pastures. • Development of resistance against anti-parasitic drugs. • Animals consuming plants that could compromise the production of safe meat. • Chemical hazards from pesticides, herbicides and fertilizers. .	• Minimize the risk of infection and disease by good pasture management and good grazing management.	• Regular deworming of livestock and companion animals. • Pastures should be on well-drained soils to discourage growth of flukes and coccidia. • Proper grazing management after treating livestock with anti-parasites. • Proper grazing management after treating pastures with manure or sludge.

Risks/hazards and control points	Recommended practices	Suggested measures to achieve recommended practice
	PASTURES, CONT.	
Control points • Animal health management (e.g. use of anti-parasites and anti-helminths). • Source of pesticides and herbicides. • Programme and rate of application of pesticides, herbicides and fertilizers on pastures. • Grazing schedule for treated pastures and animals.		• Pastures should be maintained free of hazardous plants. • Pesticides, organic and inorganic fertilizers should be applied when necessary in doses recommended by the competent authority, which will not result in unwanted residues in the meat animals. • After-treatment withdrawal periods from the pastures should be adhered to. • Animals should not be grazed in any place where environmental contamination with any residue-causing substance has occurred (e.g. pastures or water sources near mines may contain high levels of heavy metals).
	RANGELANDS AND RANCHES	
Risks • Infections from other (wild) animals. • Plants that could compromise the production of safe meat. **Control points** • Control of animal movement. • Monitoring and surveillance of rangeland.	• Ensure that there are no features in the environment that can cause recurring injury or infection to the animals or that such features are either removed or animals are protected from them.	• The competent authority should design and administer monitoring and surveillance programmes that address hazards arising from animals and plants that may compromise the production of meat that is safe and suitable for human consumption. • Measures to protect cattle from hazards should be implemented where necessary, e.g. fencing, herding.
	WATER	
Risks • Water-borne infections. • Water-borne chemical hazards. **Control points** • Agricultural chemical usage. • Effluent and waste management. • Sanitation of water troughs.	• Provide animals with clean water at all times. • Protect water sources from contamination.	• Chemical weed control should be carried out in such a way as to avoid soil and water contamination. • Effluent and manure should be managed in a way that prevents pollution of water sources. • A schedule for regular monitoring of the water quality should be drawn up, verified by the competent authority and implemented.

applicable, easily readable, non-transferable, tamper-proof and not easily copied or forged (Box 2.2).

- Central recording of identification codes issued should be entrusted to a competent central institution, and farmers should also keep adequate records of the animals they have identified.

Risks/hazards associated with animal identification and movement that could compromise the cleanliness of meat are outlined in Table 2.3 along with recommendations on how the risks could be averted and on possible control points.

Animal health

Animals that are sick or injured should have immediate access to proper treatment and care. Treatments requiring surgical procedures should only be carried out by properly trained personnel. Such treatments include dehorning, castration and tail docking. Cruel and unnecessary treatments must not be practised.

Animals should be regularly vaccinated and treated prophylactically for internal or external parasites whenever this is judged necessary by a trained person. As these needs will differ according to circumstances, veterinary advice must be actively sought in this respect.

TABLE 2.3 **Animal identification and movement**

Risks/hazards and control points	**Recommended practices**	**Suggested measures to achieve recommended practice**
	ANIMAL IDENTIFICATION AND MOVEMENT (see also Sections 3, 4 and 5)	
Risks • Transmission of disease pathogens. • Introduction of foreign pathogens and contaminants. • Stress and increased susceptibility to diseases and injuries. **Control points** • Sourcing of new stock. • Selection of animal identification system and its implementation. • Selection of livestock for disposal (e.g. sale, movement to other farms). • Management of transportation (see Section 5).	• All acquisitions, sales of animals, acquisitions of semen, losses and discards should be recorded. • Animals destined for slaughter should be transported in a manner that minimizes soiling and cross-contamination with faecal material and the introduction of new hazards. • Consideration should be given to avoiding injury and undue stress during transportation. • Zonings for disease control should be strictly observed in animal movement.	• Identify and keep records of the origin of all initial stock and animals that are subsequently introduced into the production system (e.g. births, purchases). • Animal identification practices that allow trace-back to the place of origin to the extent practicable to allow regulatory investigation where necessary should be implemented (see Section 4). • Animals destined for slaughter must be clean and healthy. • Legislation concerning vaccination, deworming and quarantine of animals before and after movement should be adhered to. • A good transportation management system should be employed (see Section 5).
	BREEDING	
Risks • Transmission of pathogens. **Control points** • Source of replacement stock, animals for finishing off and semen for artificial insemination (AI).	• Breeding bulls, semen and cows should conform to good zoonotic standards and be from herds (source) with strict sanitary control.	• Purchase all breeding stock and semen from reliable sources, registered according to standards set by the competent authority.

Animals for which treatment is not possible should be put to death using a method that does not cause further pain or distress (single bullet or injectable drugs are acceptable). Where a single bullet is used, it should be fired at close quarters into the skull at the point where the lines drawn between the eye and the opposing ear intersect. Where an injectable drug is used, it should be administered by a veterinarian or an appropriately authorized and trained person. After euthanasia, stock must be disposed of safely so that they do not pose a risk of spreading disease pathogens or contaminating the environment.

Potentially dangerous or toxic chemicals, paints, dips, medicines and disinfectants should be stored safely and well away from animals.

All animals destined for slaughter should conform to good zoo-hygienic standards and originate from herds with strict sanitary controls. To facilitate the application of risk-based meat hygiene programmes, the primary producer and competent authority should record relevant information to the extent possible on the health status of the livestock as it relates to the production of meat that is safe and suitable for human consumption. This information should be made available to the abattoir as appropriate to the circumstances.

There should be a system to facilitate the return of information on the safety and suitability of slaughter animals and meat from the abattoir to the primary producers. Producers should use such information in planning farm hygiene practices. Where producer-led quality assurance programmes exist, this information should be incorporated into the programmes in order to improve their effectiveness. The competent authority should systematically analyse monitoring and surveillance information from primary production so that meat hygiene requirements may be modified if necessary.

Risks/hazards associated with animal health that could compromise the cleanliness of meat are outlined in Table 2.4 along with recommendations on how the risks could be averted and on possible control points.

Farm environment management

As a matter of basic principle, farming practices should be environmentally sustainable and existing habitat and species diversity must be maintained and protected. Unsustainable farming practices must be discontinued. Where grazing is concerned, stocking rates and grazing rotation must be such that the ecology is improved and not degraded. Grazing management (stocking rates, frequency of rotation) must be such that positive plant succession is maintained with the aim of reaching climax vegetation (Box 2.3).

Where animals are kept in pens, these should be founded on a mild slope to prevent the accumulation of water in the pens.

Waste management must be such that no pollution of the environment, water or air occurs. Manure may be used for soil fertilization but not in such a way that long-term environmental sustainability is affected. It may be necessary to carry out soil and water analyses regularly and expert assistance must be actively sought.

Primary production of livestock should not be undertaken in areas where the presence of hazards in the environment could lead to an unacceptable level of such hazards in meat.

Risks/hazards associated with farm environment management that could compromise the cleanliness of meat are outlined in Table 2.5 along with recommendations on how the risks could be averted and on possible control points.

Labour management

The inclusion of good labour practices in an agricultural publication such as this one may be controversial, but consumers are increasingly concerned about the labour practices behind the products they buy. Labels announcing that child labour was not used in producing this item may well become a part of the future of agricultural product labelling.

For this reason, some guidelines have been given below on some of the basics, addressing issues such as child labour, adequate remuneration, health and housing.

- Farm labourers should be properly remunerated and local legislation regarding minimum salary or wage levels should be obeyed.
- Provision for adequate annual vacation leave should be made.
- The use of child labour is not permitted.
- Labourers should be given the proper

TABLE 2.4 **Animal health**

Risks/hazards and control points	Recommended practices	Suggested measures to achieve recommended practice
Risks • Zoonotic diseases. • Drug residues in meat. **Control points** • Appropriate use of veterinary medicines. • Source of veterinary medicines. • Sourcing of new stock, replacement stock and semen. • Farm sanitary programme.	• Prevent the risk of livestock infection by zoonotic agents. • Control and eradicate the presence of zoonotic agents in livestock animal populations. • Prevent the possible contamination of meat from the livestock by chemical substances (e.g. veterinary drugs, pesticides) above allowable maximum residue limits (MRLs).	• Establish a herd health plan that is approved by the competent authority for routine preventive measures. • The health plan should include official or officially recognized programmes for the control, monitoring and eradication of zoonotic agents in animal populations and the environment and notifiable zoonotic diseases. • Keep written records of sanitary control, including dates, batch number, laboratory and validity. • Transport and store vaccines, medicines and all veterinary products under the conditions specified by the manufacturers. • Drugs should be administered in correct doses at the correct application site. All relevant records of drug administration should be kept. • Withdrawal periods for veterinary medicines must be strictly adhered to. • The competent authority should provide monitoring systems that establish baseline data and guide a risk-based approach to the control of chemical hazards. • The competent authority should systematically analyse monitoring and surveillance information from primary production so that meat hygiene requirements may be modified if necessary.

protective clothing (overalls, boots and other clothing items as needs dictate).

- Labourers and their families (where they are resident on-farm) should be provided with adequate housing, bathing and toilet facilities, and the costs thereof must not be subtracted from their wages.
- Where rations are supplied to labourers, they should be of adequate nutritional value, and wages may be adjusted as allowed by local legislation.
- Labourers in charge of livestock should be given adequate training in the handling of the animal species under their control.
- Livestock management practices on the farm should not place the health and safety of farm workers at risk.
- Where disciplinary action is necessary, acceptable practices (written warnings for lesser misdemeanours) should be followed. Summary dismissal of labourers is allowed only for the most extreme forms of misconduct.
- Labourers (and where appropriate, their

Box 2.3 Ecological pointers

Climax vegetation can be thought of as the greatest diversity of plant species a piece of land is capable of supporting - such a plant community is capable (in the absence of disturbance) of indefinitely maintaining itself and is regarded as stable. Properly managed animal impact should be considered as a tool for maintaining stability and not as a disturbance.

Regular evaluation of species mix and extent of ground cover will provide some clues as to the ecological health of an area.

PLANT DIVERSITY SCORING

Poor: Less than 10 different plant species visible in a given area

Medium: 10-15 different species visible in a given area

Good: More than 15 species visible in a given area

EROSION SCORING

Poor: Surface litter absent (removed by wind/water), plant roots visible, presence of erosion gullies

Medium: Evidence of surface litter deposited against obstacles, soil "pedestals" around plant roots

Good: Evidence of accumulating surface litter, little evidence of water flow patterns on the surface

Such "rule-of-thumb" evaluations are easy to do, and if carried out regularly, will provide some indication as to whether a piece of ground is being managed so that increasing diversity (i.e. positive succession) is being promoted.

Source: adapted from Savory, 1999.

family members) must have ready access to medical care.

- Records should be kept of wages paid, training given and disciplinary actions undertaken.

All principles, laws and regulations regarding hygiene and safety during any operation related to livestock production must be followed in order to avoid any health hazard to workers and consumers.

Risks/hazards associated with labour management that could compromise the cleanliness of meat are outlined in Table 2.6 along with recommendations on how the risks could be averted and on possible control points.

On-farm record-keeping

Why should records be kept of on-farm activities? The answer is very simple – keeping good records makes good management possible. Maintenance of records across a broad spectrum of farming activities enables the producer to plot his/her progress in terms of production levels, income, state of the environment and other parameters.

The availability of records also facilitates the process of farm audits and inspections where external bodies are involved in verifying the implementation of good practices.

There is a wide range of records to be kept with respect to any farming enterprise, and such record-keeping can become very sophisticated. As the aim of this publication is to assist smaller-scale farmers in developing countries, every effort has been made to keep the approach simple.

In terms of the farming practices outlined in the preceding pages, there are a number of records that are essential. These are:

Livestock population register

At the very minimum, records must be kept of births, deaths (with cause where known), purchases and sales of each species of livestock on the farm (Figure 2.1). Preferably, each birth should be recorded individually and the identity code allocated to each animal noted. Individual identification also makes it possible to record the sale and destination of each animal, and facilitates the keeping of records on individual medication.

The register must be backed up by the normal receipts or waybills that accompany the

TABLE 2.5 **Farm environment management**

Risks/hazards and control points	Recommended practices	Suggested measures to achieve recommended practice
Risks • Microbial and parasitic infection of livestock. • Microbial contamination of livestock. • Chemical contamination of feed/fodder, water and livestock. • Physical contamination of feed, water and livestock. **Control points** • Chemical usage. • Effluent and manure management. • Reclaimed water/waste usage.	• Ensure that pesticides and their containers do not contaminate soil, water and animal feeds. Strictly follow legal prescriptions for handling, application and disposal of pesticide leftovers and empty containers with emphasis on the triple washing method. • Waste management must be such that no pollution of the environment, water or air occurs. Manure may be used for soil fertilization but not in such a way that long-term environmental sustainability is affected. • Grazing management (stocking rates, frequency of rotation) must be such that positive plant succession is maintained with the aim of reaching climax vegetation. • Carcasses should be disposed of in such a way that they do not pollute the environment (see Box 2.4).	• A recognized protocol for the storage, usage and disposal of all chemical substances used on the farm (e.g. medication and vaccines, fertilizers, paints) should be drawn up and implemented. • Pesticide application equipment should conform to safety and maintenance recommendations. • Where possible, a recognized protocol for farm waste management, disposal of dead carcasses, etc. to prevent pollution of the environment and the spread of infectious diseases to animals or to humans should be drawn up and implemented. • Any deaths that are suspected to be from disease should be reported and carcasses should be available for post-mortem evaluation in such cases. • If necessary, a programme for regular soil and water analyses should be established with the assistance of the competent authority.

Box 2.4 **Carcass disposal**

Ideally, animal carcasses should be disposed of at a rendering plant. Disposal methods on the farm, such as burial or burning in the open, may cause water or air pollution. However, if no other options are practical, carcasses may be buried on the farm as long as the following guidelines are met:

- The burial site is at least 250 m away from any well or spring that supplies water for human consumption or farm use.
- The burial site is at least 30 m from any other spring or watercourse and at least 10 m away from any field drain.
- The bottom of the burial pit should have at least 1 m of subsoil above it so that the carcass is covered by at least 1 m of soil below the top soil.
- The bottom of the burial pit must be free of standing water.

Source: adapted from Latvia University of Agriculture, 1999.

purchases and sales of livestock so that registers can be reconciled with individual transactions.

Feed register/grazing records

Where a farmer has access to fenced-off camps or fields, the number of animals grazed in each camp, and the periods during which they are grazed, must be recorded. Such records, when kept together with a record of the ecological status of each camp, will enable the farmer to track progress with environmental management. The use of communal grazing makes such management processes very difficult, however, and it may not always be possible to keep a grazing register.

However, the use of supplementary feeds or exclusive feeding with zero grazing renders the keeping of records absolutely essential. Feeds may well be a source of toxins or infection, and accurate records of their use must be kept. The

TABLE 2.6 **Labour management**

Risks/hazards and control points	Recommended practices	Suggested measures to achieve recommended practice
Risks • Tasks not adequately carried out leading to risk of contamination of livestock feeds, water and environment. **Control points** • Training of workers. • Supply and maintenance of protective clothing and work equipment.	• Workers should be supplied with protective clothing and equipment that conform to safety and maintenance recommendations. • Only trained labourers using appropriate individual protective clothing should be allowed to carry out any given task.	• Provide periodic training to workers. • Supply appropriate protective clothing and equipment in good working condition. • Recommended storage conditions, maintenance and replacement schedules for protective clothing and equipment should be strictly adhered to. • Make sure all safety rules are observed during operations. • Keep records related to health and safety.

minimum details to be recorded are: the name of the feed (if a proprietary brand is used); the composition of the feed (if an own mix is made); the number and identification/category of animals fed; the period during which they were fed; and the amount of feed consumed during that period (Figure 2.2).

Records of purchase and labels of the feed used must be kept for reconciliation with the register.

Treatment/drug register

Consumer concerns regarding residues in meat make the keeping of a treatment register essential in preserving the credibility of production methods. It is accepted that animals may need medical treatment from time to time; what is required is the assurance that the treatment was correctly administered and that withdrawal times were observed.

An on-farm treatment register should contain

FIGURE 2.1 **Example of a livestock population register**

LIVESTOCK POPULATION REGISTER

Farmer's name and address .. Year and month /

Species .

Date	Previous total	Births	Purchases	Sales	Deaths	New total

FIGURE 2.2 **Example of a feed/supplementary feed register**

FEED/SUPPLEMENTARY FEED REGISTER

Farmer's name and address . Year

Name (proprietary feed)	Composition (if own mixture)	Number/ identification of animals fed	Period (from/to)	Quantity fed

the following information: the date of the treatment; the name and dose of the medication or vaccination used; the description or identification of the animal/s treated; the length of the withdrawal period; and the date of expiry of the withdrawal period (i.e. the date after which the animal is again eligible for normal production). For a suggested layout of such a register see Figure 2.3.

Worker's paysheet

Each worker should have a sheet showing his/her name, date of birth and record of weekly/monthly payments, giving the date of the payment and the amount against the worker's signature or thumbprint. This is not only good practice in terms of monitoring labour costs, but is an added protection for the farmer against possible claims of malpractice with respect to remuneration (Figure 2.4).

Financial records

While outside the scope of this publication, it goes without saying that financial records are essential even for the smallest of farmers. At the very least, a monthly income and expenditure sheet should be kept, giving details of money spent on labour and other inputs, and details of money obtained through sales of production.

Supervision and inspection

Livestock should be kept under supervision of a person trained in their care and feeding. Ideally, they should be seen once a day by such a person, but under extensive farming conditions, weekly checks may be more practicable. They should be checked for health, and their feeding and drinking facilities must be inspected. Animals or facilities requiring attention must be reported without delay to the person responsible.

In order to verify the implementation of the standards elaborated here, external inspections by an authorized body must be undertaken on a regular basis (Photo 2.5). Such inspections should be carried out at yearly intervals and include not only an inspection of livestock and facilities, but also a detailed audit of all the records outlined above.

- The inspection authority should compile a suitable register of all farms intending to apply the good practices (i.e. an accreditation system should be implemented) and provision should be made for central recording of all inspections.
- Inspectors/auditors should carry out uniform inspections on all farms involved in any standards scheme, and should use a standard inspection report/checklist (Box 2.5).
- Inspection reports shall be collected and stored centrally by the inspection agency, and farms not complying with the requisite standards must be placed under sanction, e.g. exclusion from relevant markets, reduction in producer price.
- Inspectors shall inform farmers of any shortcomings noted during inspections so that farmers may take corrective action.

R. PASKIN, MEAT BOARD OF NAMIBIA

PHOTO 2.5
A farm inspection in Swaziland: such inspections are the cornerstone of quality assurance in the livestock industry

FIGURE 2.3 **Example of an on-farm treatment register**

ON-FARM TREATMENT REGISTER

Farmer's name and address . Year

Date	Treatment/drug	Description/ identification of animals	Withdrawal period	Expiry date withdrawal

FIGURE 2.4 **Example of a paysheet**

WORKER'S PAYSHEET

Name of worker . Date of birth

Date of start of employment ..

Date	Amount paid	Signature of employee

Leave record: From . To .

Box 2.5 Example of farm inspection report

Questions 1- 24 are answered yes/no; give details of problems/defects noted at question 25.

FARMER'S NAME: **HOLDING NAME AND NUMBER:**

		Yes	No
1.	Is the origin of all purchased livestock known?	❑	❑
2.	Are there clear records of all movements to and from the farm?	❑	❑
3	Are all animals identified in accordance with scheme rules?	❑	❑
4.	Are records kept of all treatments?	❑	❑
5.	Can treatment records be reconciled with accounts for medicine purchases and veterinary consultations?	❑	❑
6.	Are medicines and vaccines correctly stored?	❑	❑
7.	Are records kept of all feeds given?	❑	❑
8.	Can feed records be reconciled with proofs of purchase?	❑	❑
9.	Are these feeds free of meat-and-bone meal?	❑	❑
10.	Are these feeds free of poultry manure?	❑	❑
11.	Are these feeds free of growth promotants?	❑	❑
12.	Are feeds correctly stored?	❑	❑
13.	Were all animals presented for inspection?	❑	❑
14.	Was their overall condition satisfactory?	❑	❑
15.	Are livestock raised on natural grazing?	❑	❑
16.	Is the grazing in a satisfactory condition?	❑	❑
17.	Do farm practices minimize stress?	❑	❑
18.	Are handling facilities acceptable?	❑	❑
19.	Do animals have free access to clean water?	❑	❑
20.	Where appropriate, is shelter for animals sufficient?	❑	❑
21.	Do animals suffering from sickness or injury receive immediate attention?	❑	❑
22.	Does the farmer adhere to withdrawal periods when treatments are administered?	❑	❑
23.	Are compulsory vaccinations up to date?	❑	❑
24.	Are general records pertaining to animal numbers acceptable and up to date?	❑	❑
25.	Details of shortcomings:		

Signature of Farmer: Signature of Inspector: Date:

• Checklist of relevant action for implementation of primary production standards •

Formal implementation of good practices in primary production is not an easy matter, as it requires the mobilization of a large number of farmers in order for it to be meaningful.

The first step is awareness building in the target farming community. This step is nothing more than awareness creation, informing farmers of what might be required of them, and the reasons for implementing such standards.

Following awareness building, the next step involves research to determine what standards would be applicable and to elaborate a set of standards (based on these guidelines) that would be acceptable and practicable for the farmers and acceptable to the markets they serve.

The next phase would require a series of farmer training initiatives and identification and training of other stakeholders, including the inspection agency and its inspectors. This would be followed by a gradual phasing-in of the standards on cooperating farms, with constant evaluation and modification of the system as necessary.

The checklist below summarizes these phases.

ACTIVITY	✓
Farmer awareness campaign:	
Message formulation	
Radio/TV	
Newsletters/pamphlets	
Meetings	
Elaboration of appropriate standards:	
Assessment of market needs/applicable regulations	
Assessment of farming systems/farmer capabilities	
Compilation of a set of standards	
Elaboration of suitable farm record formats	
Consultation with farmers	
Reformulation of standards and record formats	
Training:	
Identification of stakeholders	
Consultation/compile training material with farmers' organizations	
Consultation/compile training material with inspection agency	
Consultation/compile training material with government extension agents	
Consultation/compile training material with livestock agents/traders	
Consultation/compile training material with veterinarians	
Consultation/other	
Compilation and printing of training materials	
Training of farmers	
Training of inspection personnel	
Training of government staff	
Training of traders	
Training of veterinarians	
Other training	
Assessment of progress and determination of implementation deadline	
Implementation phase:	
Final compilation and printing of standards manuals and record forms	
Compilation and printing of inspection checklists/report forms	
Distribution of standards manuals and record forms	
Distribution of inspection checklists/report forms to inspection personnel	
Public announcement on implementation date - mass media, pamphlets, etc.	
First round of inspections/audits	
Assessment of progress	
Modifications to implementation as necessary	

Summary

- Implementing good practices in primary production involves the application of recommendations and knowledge to on-farm practices in order to achieve sustainable production and yield a safe and healthy product. The aim is to provide assurance to consumers that the product on their tables is both safe and ethically acceptable.
- Good agricultural practices are applicable in all livestock production activities and related areas, encompassing animal welfare, feeding, health, identification, environmental sustainability and labour relations.
  - Animal welfare – in terms of nutrition, health, living space and medical care – must be safeguarded. Areas of concern include:
    - access to adequate and safe feed and water;
    - social contact between animals;
    - sufficient living space;
    - protection from injury and disease and, should they occur, access to proper treatment;
    - protection from climatic extremes.
  - Shelter and handling facilities should be provided for the comfort, protection and ease of handling of livestock and not for the purposes of intensification. The facilities should be planned according to the size of the herd, expansion plans, cleaning and disinfection needs, disposal of animal excrement, the materials available and the availability of good quality water.
  - Standards for feeding should concern the following:
    - safety of feed and water;
    - adequacy of feed and water, taking into account the physiological needs of the animals;
    - grazing practices that match the needs of the animals and include supplementary feeding where necessary. Grazing practices should have no adverse effects on the environment and on plant species diversity in the rangelands;
    - freedom from growth promotants, meat-and-bone meal, poultry manure and dangerous contaminants.
  - Livestock identification is basic to management, record-keeping and traceability systems. The means used for identification should be readable, non-transferable and easy to apply.
  - Animal health considerations at the primary production level should mean that:
    - Animals are protected from disease and injury. Should these occur, the animals should have immediate access to appropriate treatment and care from suitably trained personnel.
    - All animals destined for slaughter conform to good zoo-hygienic standards. Primary producers should have strict herd sanitary control programmes that document the general health status of slaughter animals and implement practices that maintain or improve that status.
    - A system that facilitates the return of information on the safety and suitability of slaughter animals and meat from the abattoir to the primary producers is established and maintained. The information should be incorporated in herd sanitary control programmes.
  - Farming practices should be environmentally sustainable and such that there is no pollution of the land, water or air, and that existing habitats and species diversity are maintained and protected.
  - Good labour practices must be employed. These include adequate training, remuneration and protection of health of the employees and the exclusion of child labour.
  - Basic record-keeping would include the following:
    - on-farm livestock register, showing births, deaths, purchases and sales;
    - feed register giving details of feed used, animals fed and period of feed usage;
    - treatment register giving date and full details of treatments administered, and the animal/s treated;

- paysheet records showing details of each labourer and remuneration paid;
- minimal financial records to reflect income and expenditure;
- the keeping of all transaction records relating to any of the above.

- The farming enterprise must be under adequate farmer supervision, and should be subject to regular audits by a credible external entity.

- Implementation of good practices in the primary production sector necessitates the following processes:
  - sensitization of the primary producers about the required practices;
  - research to determine what standards would be applicable and to elaborate a set of standards (based on the guidelines set out in this manual) that would be acceptable and practicable to the farmers and acceptable to the markets they serve;
  - a series of farmer training initiatives; identification and training of other stakeholders, including the inspection agency and its inspectors. This would be followed by a gradual phasing-in of the standards on cooperating farms, with constant evaluation and modification of the system as necessary.

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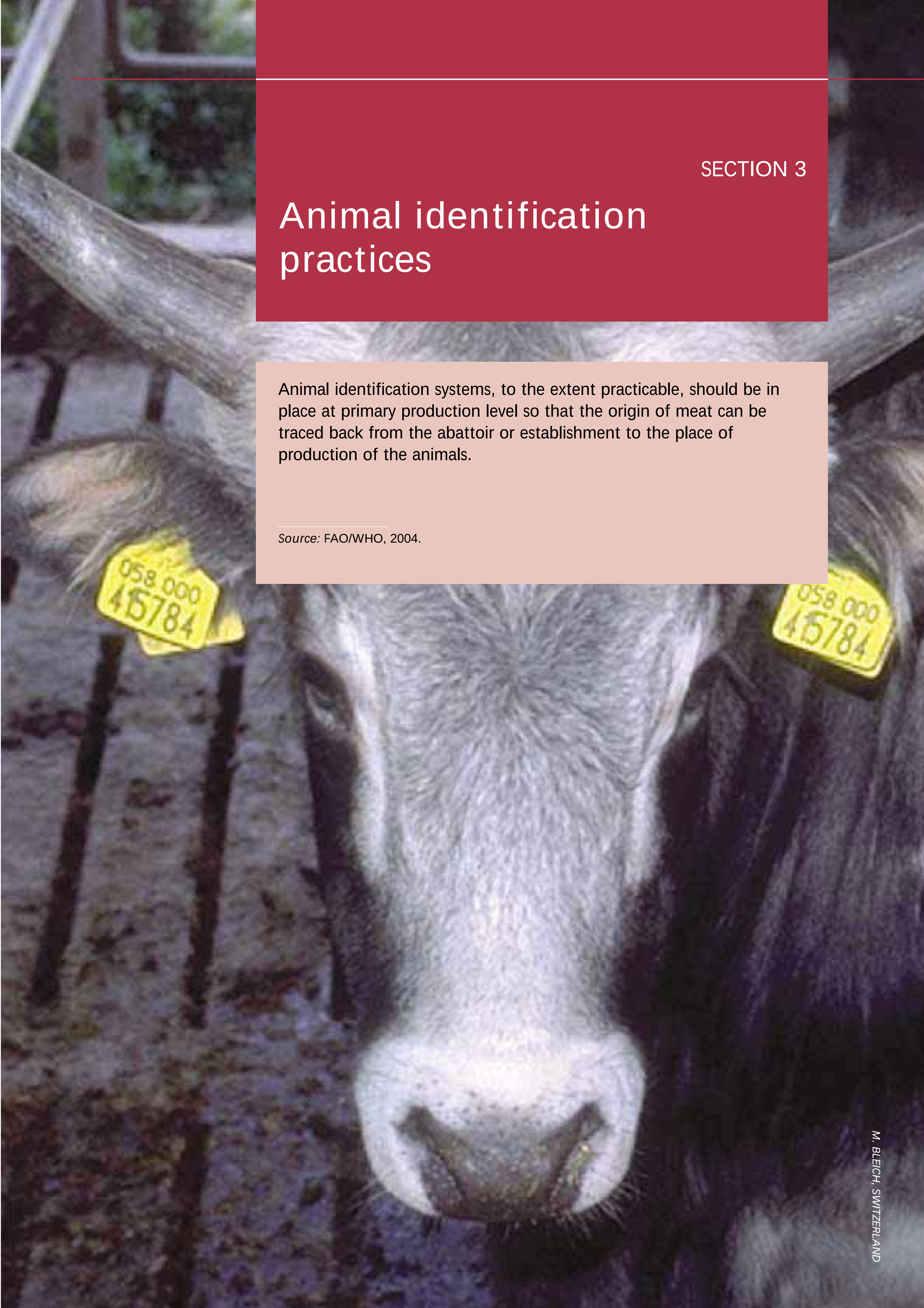
SECTION 3

Animal identification practices

Animal identification systems, to the extent practicable, should be in place at primary production level so that the origin of meat can be traced back from the abattoir or establishment to the place of production of the animals.

Source: FAO/WHO, 2004.



M. BLEICH, SWITZERLAND

INTRODUCTION

Livestock identification is essential to modern farming and underlies all successful management. Various types and methods of identification have been developed for application under different circumstances.

In the earliest times, branding was used to associate animals with their owners. Many pastoral tribes developed sophisticated systems of identification based on skin colours and patterns.

The need to identify an animal in order to track its path through the production chain and eventually into food products – known as traceability – has become central to many identification systems in recent times.

THE RATIONALE FOR IDENTIFICATION

There are two main reasons for putting identification marks or devices on animals: proof of ownership and management/traceability.

Establishing proof of ownership

Since the earliest of times, people have sought means of identifying livestock in order to place their mark of ownership on them. Livestock recovered after theft could be returned to their rightful owner, and the person in whose hands they were wrongfully found could be prosecuted.

R. PASKIN, MEAT BOARD OF NAMIBIA

PHOTO 3.1
Avoid: unreadable cattle brands in Namibia - branding cannot be used for the clear and unambiguous identification needed for modern traceability

Hot branding

Branding animals (Photo 3.1) with hot irons has been in use for some 4 000 years. While placing a permanent mark on the animal, branding has several disadvantages:

- Size limitation means that the number of symbols that can be put on to the animal's skin is limited and individual identification cannot be effected.
- Branding damages and devalues the animal's hide – the more prominent the mark, the greater the damage and the financial loss.
- A poor branding technique or the use of ambiguous symbols negatively affects readability of the brand. The use of series of coded symbols as is current in modern practice renders readability difficult.
- Blotching of brands – a technique of overbranding used by stock thieves – easily renders brands unreadable.
- Normal growth of the animal distorts brands applied at a young age, so that by the time the animal reaches adulthood, the brand is no longer legible.
- Growth of hair, especially the forming of a long hair coat during winter, can often make brands almost invisible.
- Different stock owners may – intentionally or unintentionally – use the same or similar brands, thereby causing confusion.
- The position of brands on the animal – usually placed at the lowest possible points on the limbs to minimize damage to the hide – also makes reading them difficult, especially when animals are standing in pens, and the structure of the pen obscures the view.
- The fact that branding is left to the owner of the animal means that brands, even within the same herd, vary greatly in appearance and readability. Brands can be copied illegally and used by others. Lack of central control over the use and application of brands underlies many of the problems experienced with their use.
- Welfare questions have also begun to be raised with respect to the use of brands. The fact that branding causes pain and distress can no longer be ignored.

Despite the obvious disadvantages of branding, the technique remains cheap and for this reason it is still used to effect owner identification, especially in developing countries. If brands still have any use at all, it is to identify an animal's owner. They cannot be used to identify an animal for the purposes of modern management and traceability. Where there is currently no feasible alternative to hot branding for identification of animal ownership, the standards outlined in Box 3.1 should be rigorously adhered to.

Cold branding

Cold branding, using liquid nitrogen to cool an iron to extremely low temperatures for the purpose of marking an animal, has all the disadvantages of hot branding – except that it is presumed to be less painful. It is also expensive and difficult to apply, and out of the reach of poorer farmers.

Tattooing

The use of tattoos has as its underlying philosophy the identification of the animal's ownership, as is the case with branding. There is no central control over the application of tattoos, the number of symbols that can be used on any individual does not enable individual identification and – most importantly – readability presents a great problem. Animals are normally tattooed inside their ears, which means that an animal has to be physically caught and examined, first to establish whether it has been marked at all, and second to attempt to make out the symbols that have been used in the tattoo. These difficulties render tattoos usable only for ownership confirmation. Another disadvantage comes with identifying successive owners – whereas an animal may be branded at several places on its body to mark several successive owners, only two ears are available for tattoo marks.

Box 3.1 **Hot branding**

Where branding is used for proof of ownership, the following standards should apply:

- The characters/symbols used should be large and clear (at least 7 cm high).
- Characters should be alphanumeric and not pictorial, for ease of storage on a database register.
- The brand should be placed at a prominent place on the hide, e.g. upper thigh, rump or shoulder.
- Animals must be firmly restrained for branding.
- The branding iron must be heated to red heat and pressed to the animal's skin for 3- 5 seconds.
- The iron must be re-heated to red hot before use on another animal.
- Owner brand symbols should be registered with a central authority.

Management and traceability

The need for identification of stock has evolved. In many circumstances, confirming ownership is no longer the central need. Animals themselves need to be identified in order to record their progress in terms of weight gain, fertility, susceptibility to sickness, etc. and thus facilitate breeding selection and management. Identification of animals is also necessary when carrying out diagnostic procedures (e.g. testing for brucellosis) so that animals that show up serologically positive can be culled.

More recently, the need has arisen to identify animals for the purposes of traceability. Where a problem is detected in a live animal far along the production chain, or even in meat derived from the animal (e.g. the detection of potentially harmful tissue residues or a disease such as bovine spongiform encephalopathy [BSE]), it has become necessary to trace backwards along the production chain to establish when and how the problem occurred. Steps can be taken to correct the problem, and give reassurance to consumers that quality control of the production chain is in place.

Various techniques for placing identifying marks on or within an animal's body have been developed for effecting identification that meets these management needs.

Visual tagging

Tagging animals – usually with plastic tags affixed to their ears – has been in use for decades. Many farmers have used handwritten tags as a management tool. Durability of these tags has long been an issue, especially as the tags often fall out or become bleached and unreadable.

Great strides have been made in the production of tags, however, and tamper-proof dual tags that can be printed with laser

R. PASKIN, MEAT BOARD OF NAMIBIA

PHOTO 3.2
GOOD PRACTICE: ***calves with double ear-tagging in the United Kingdom: tamper-proof pre-printed tags are widely used for animal identification***

R. PASKIN, MEAT BOARD OF NAMIBIA

PHOTO 3.3
GOOD PRACTICE: ***animal with double ear-tagging in Italy***

printing technology are now available that have a high retention rate and remain readable for many years (Photos 3.2 and 3.3). Tags can easily be inserted by most farmers using an applicator that correctly fits the tag to be used.

These tags can be printed with alphanumeric codes several characters long which will effectively and uniquely identify the individual animal, and are clearly and quickly readable from a distance of around 2 m. The tags can easily last the life of a slaughter animal and can be used to register its progress at all the steps along the production chain. Within their own management systems, farmers can easily establish databases based on such identification to monitor progress in terms of other parameters such as weight gain and feed conversion.

Tags have been developed in various shapes and sizes for different species of animal, with larger plastic tags in vogue for cattle and buffalo and small tags – either plastic or metal – being more suited to use in sheep and goats.

Alphanumeric codes may be used on these tags and are easily stored in computerized databases. The main disadvantage here is that the recording of an animal's identity as it moves along the production chain must be done manually, and may be subject to errors in transcription.

Bar-coded tags

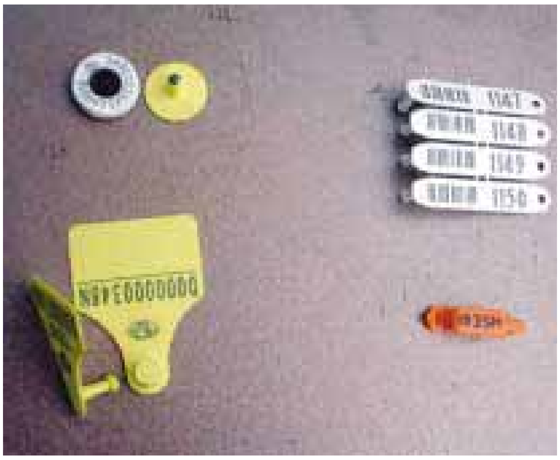
The advent of bar codes has brought about further progress in ear-tag development. Tags printed with bar codes have all the advantages of visual tags in terms of retention and readability – except that reading and recording are effected electronically through the use of a bar code scanner or reader. The possibility of human error is thus eliminated. However, there is one problem – the presence of dirt on a bar code often renders it unreadable, meaning that the tag may have to be physically cleaned before it can be read.

Another obvious disadvantage is the need for an electronic infrastructure – a system of computers linked to scanners – for bar code usage to be effective on a wide scale. The financial outlay associated with bar code usage thus limits its use to countries where the needed infrastructure can be afforded and maintained.

Bar coding is usually combined with visual coding.

RFID tags

The latest development in identification – the use of radio frequency identification devices (RFIDs or microtransponders) – has advanced the use of technology in livestock identification still further than that of bar codes. Transponders are available in several types that have different



R. PASKIN, MEAT BOARD OF NAMIBIA

PHOTO 3.4
A variety of tags. Clockwise from top left: tag with microtransponder (in the female half of the tag); bar-coded fold-over sheep tags; fold-over sheep tag in locked position; male/female visual tag for a bovine

capabilities in terms of programmability (the more sophisticated chips can actually be used to record information about the animal in which they have been placed) and in terms of the distance from which they are readable. The cheapest chips can be used for pricing items in supermarkets and are readable by a scanner from a distance of only a few centimetres, while more powerful versions can be read electronically from several metres.

Microtransponders have the same disadvantage as bar codes, however. There is a need for an expensive electronic infrastructure to make them work, and the transponders themselves are very expensive. An ear tag containing a transponder may cost two or three times more than a simple visual tag. RFIDs may break down and become unusable, although this happens in a very small percentage of cases. In the final analysis, transponders represent one of the greatest strides made to date in relatively easy identification of livestock.

RFID implants

The subcutaneous implantation of microtransponders is done with a device not unlike a large hypodermic syringe, and it should be able to be carried out by many farmers. These implants are normally placed beneath the skin of the ear.

Apart from the costs and other disadvantages that apply for tags containing microtransponders, they may also migrate under the skin, meaning that they will have to be searched for in many cases. Outwardly, the animal bears no sign that it has been marked with a transponder. This may be of great help in catching livestock thieves, but it means that every person wishing to establish the identity of an animal has to carry an electronic scanner.

Nevertheless, the use of subcutaneous transponders makes it possible to identify livestock invisibly and permanently in a more reliable manner than branding or tattooing could ever do.

RFID boluses

Microtransponders can also be placed inside ceramic boluses which can be dosed to young ruminant animals and remain permanently in the reticulum. While this permanently and invisibly identifies the animal, the dosing procedure may be difficult and out of the reach of many farmers. Boluses are notoriously expensive.

Intrinsic identification

Various other means of identification – the recording of unique retinal patterns inside the eye, noseprints, genetic fingerprinting of animals – are all in their pioneering stages. All require complex and expensive apparatus for the testing/recording of each individual, together with the establishment of sophisticated databases. While these methods are all more foolproof than those listed above, they are not at this stage regarded as practical and cheap enough for day-to-day use on the farm.

A summary of the characteristics of the different livestock identification systems is presented in Table 3.1.

BASIC REQUIREMENTS FOR AN IDENTIFICATION SYSTEM

Having been through an overview of the need for identification, as well as the means or devices available, it now becomes pertinent to note the requirements of an identification system. Knowing what is needed, as well as what resources are available, will eventually lead to the choice of an appropriate means.

Ideally, an identification system should meet the following requirements:

- The means of identification should be clear and easily readable (visually or electronically).

TABLE 3.1 **Comparison of livestock identification systems**

ID type	Readability	Cost	Durability	Transcription	Central control
Hot branding	poor	cheap	good	manual	not possible
Cold branding	poor	expensive	good	manual	not possible
Tattoo (in ear)	very poor	cheap	good	manual	not possible
Ear tag (visual)	good	reasonable	fair	manual	possible
Ear tag (bar code)	good (if clean)	reasonable	fair	electronic	possible
Ear tag (transponder)	excellent	expensive	good	electronic	possible
Subcutaneous transponder	excellent	expensive	good	electronic	possible
Intra-ruminal transponder	excellent	expensive	good	electronic	possible
Genetic methods	difficult	expensive	good	complex	essential

- The identification used must be centrally produced and controlled so as to establish a broad norm or standard in terms of quality and readability and eliminate human error as far as possible. Achieving uniform quality throughout is essential.
- The means of identification should not be easy to copy (to prevent forgery) and should not be transferable from one animal to another (to prevent theft of identification and fraud). This means that the tag, transponder, bolus or any other means used should physically break and become unusable should an attempt be made to remove it from one animal and place it on another. Central production of the device by sophisticated means will also place copying it out of the reach of the average person.
- The means of identification should also be durable – i.e. capable of remaining on or in the animal for a good length of time. This may mean from birth to slaughter or, in the case of dairy animals, for the entire productive life of the animal. Practically, for ear tags, this means that a high retention rate is required.
- The means of identification should not cause pain or discomfort to the animal, should not damage the hide or the meat, and should not become a portal of entry for infection. It should also not contaminate the meat in any way.
- The form of identification should be easy to apply to the animal and not require expensive or sophisticated equipment; the identification itself should also not be excessively expensive.
- Effective use of the identification system should be on a wide scale but not require an infrastructure beyond the means of the farming community or country that is using it.

MAKING THE RIGHT CHOICE

Given that this publication is aimed mainly at farming communities in developing countries, it now becomes possible to begin making an evaluation of some of the methods available against the background of country needs.

Identification is now associated not only with management needs, but also with market requirements. New standards in terms of traceability of the animal and its products are now becoming the norm, increasing the need for individual identification. Increasingly sophisticated veterinary disease surveillance and control measures also require identification based, if not on the individual, at least on the group.

Brands and tattoos, with all their attendant disadvantages, should be used only where there is no current feasible alternative for identification of animal ownership, and should be phased out as soon as possible. Methods based on genetic characteristics (amino acid sequencing, noseprints, etc.) can also be discounted for developing farming communities on grounds of cost.

This leaves tags in their various forms, and the various forms of microtransponder. While the best methods will boil down to a tag-and-transponder combination (with the tag in the ear and transponder in the tag, under the skin or in the rumen), these will be expensive. The technology is tried and tested, but costs may be excessive.

The most cost-effective option for most developing countries will be either a combination of visual and bar codes on tags, or visual ear tags alone.

It goes without saying that the tags will need to be centrally produced and distributed in order to exercise the maximum control over the identification system and ensure quality norms; they will also have to be constructed so as to be tamper-proof. In practice, this may mean the use of a male–female tag combination where the two halves of the tag lock into each other, or the use of a folding tag where two parts of the same tag fold over and lock into each other.

Farmers are more likely to opt for larger plastic tags for cattle or buffalo, while smaller folding aluminium or bronze tags are likely to be chosen for sheep or goats. Small button-type plastic tags may be popular for pigs, and folding metal tags work well for ostriches.

The requirements of the market and the farming community need to be combined with economic and practical considerations when making the choice. It is important, however, that standards not be relaxed in such a way as to compromise the integrity of the system. Using cheap tags which fall out, or allowing farmers to write their own tags, or using cheap reject transponders with a high failure rate will undermine an identification system and defeat its purpose.

ESTABLISHING A CENTRAL REGISTRY

Aside from the technical issues surrounding the methods of identification, there is also the need to establish a registry where codes relating to livestock identification can be stored. An institution that registers identification marks or codes provides a central reference point that enables the origin of an animal to be established and determines means and standards for identification.

Functions of a central registry

The organization charged with keeping records of livestock identification would be under state supervision (if such identification were mandatory) or under the control of a private organization (e.g. an agricultural union) if the identification scheme were voluntary and private. Such a body would have some or all of the following functions:

Creation and maintenance of a register of identification codes of livestock

A comprehensive register listing all identification codes in use, linking them to the animals, their owners and the properties/ holdings on which the animals are kept.

Creation and allocation of codes

Livestock owners would be required to apply for codes with which to identify their stock; the registry would allocate these codes so that animals or groups of animals would be uniquely identified. This would eliminate the possibility of different livestock owners using the same identification codes.

Determining standards and methods for livestock identification

The central registry would also set the standards and specifications for the means of identification to be used, e.g. if ear tags were to be used, the registry would determine the type, size, colour and coding (alphanumeric, bar) to be used.

Other issues to be addressed would be the age at which identification is to be applied to an animal (at birth, at weaning or on leaving the farm of birth); and the level of identification preferred (group identification, where all animals wear the same identification mark, or individual identification, where each animal is assigned a unique identity number).

Control of distribution of identification devices

There should be a mechanism to control or channel the ordering of approved identification devices from the farmer to the manufacturer and back to the farmer to ensure that the correct identification codes are used as determined by the registry and that standards are adhered to.

The farmer would order a number of devices, which he/she would then assign to the animals to be identified; the code given to each animal would, in the case of individual identification, be reported to the registering authority. The authority would have a record of the identification codes allocated to the farmer, combined with a list of codes given by the farmer to individuals.

Structuring identification codes

How codes are structured depends on the type of device used and the level of identification required. When a system uses alphanumeric visual coding or bar coding, there is a fair amount of latitude in terms of how codes can be structured, which may affect the ease with which a system works.

Should identification be required only at group level, and the group to be identified is the group or herd to which an animal belonged immediately prior to slaughter, the system can be very simple. A code can be structured so that a part of the code, for example, designates the district where the herd is kept, another part designates the farm, and another part the owner (if the farm has more than one owner). Should the identification system require individual identification of the animal, a final component of the code could identify the individual animal (Box 3.2).

Where visual coding is used, and code symbols are widely known, the origin of an animal or group of animals would be easily recognized (at least to district level) without needing to refer to the central register.

Where individual identification is required for the entire life of the animal, and there is a possibility that the animal will move to a number of different holdings during its lifetime, it matters little that the identification code be structured in a particular fashion. A code designed to designate a particular farm becomes obsolete once the animal is moved. This is particularly true where unique digital codes are pre-programmed into microtransponders by their manufacturers; structuring codes in a specific way is then not possible.

Creating a register

A register of codes could be either manual or computerized. Where a relatively small number of farms are involved, and identification to herd level only is required, a manual system would present few problems. However, where a large number of herds are involved, and particularly where individual identification is needed, the use of a computerized system is unavoidable.

Software for such registers is commercially available, but often at excessive cost. For developing countries, it is usually far cheaper (and simpler) to commission the programming of a system tailored to local needs.

An identification register should meet the following minimum specifications:

- The register should contain a comprehensive list or database of all codes issued and the names of the approved livestock owners to whom they have been issued.
- The register should also contain a list of all properties or holdings owned by the farmers to whom identification codes have been allocated.
- There must be a system of cross-referencing to enable linkage of animals and their

Box 3.2 **Structuring visual identification codes**

The code AC002001 might be broken down as follows:

AC	**002**	**001**
(district symbol)	**(farm registration no.)**	**(farmer identification)**

All animals from this farm would carry the code AC002001 should they belong to farmer A; if another farmer, farmer B, also had animals on this same farm, they might carry the code AC002002, for example.

Should one wish to go a step further, extra digits could be added to identify the individual animals on these farms. Should farmer B have 20 cattle, they would be marked with codes running (for example) from AC002002001 to AC002002020.

If these codes were printed on ear tags, they could be broken up for ease of reading, perhaps with the group or herd code separated from the animal's individual serial number. For example, the fifteenth animal of farmer B would be identified as follows:

AC002002
015

R. PASKIN, MEAT BOARD OF NAMIBIA

PHOTO 3.5
"Male" and "female" halves of a pre-printed tamper-proof bovine ear tag: note the presence of the computer-generated logo intended to make forgeries difficult

identification codes to their owners and to the holdings on which they are kept. The system should enable queries using any of these variables as a basis, e.g. a query based on an animal's identification code should show the animal's owner and the farm where it is kept, while a query based on the holding should return the names of owners using that holding, together with the identification codes of their livestock.

- The full particulars of all livestock owners, including physical and postal addresses and telephone numbers must be stored in the database.
- Where individual identification of animals is required, at least the species, sex and approximate birth date of the individual should be kept in the register; further data on breed birth mass, weaning mass and other performance data are optional.

STANDARDS FOR THE MEANS OF IDENTIFICATION

Standards for the means of identification (i.e. tags or transponders to be used) are essential and must be carefully spelled out. The list below serves as a minimum set of standards that would satisfy a modern animal identification system.

- The means of identification used should not be capable of contaminating meat or offal in any way, and should not damage the meat or the hide of animals.
- Once an animal is in a head clamp, identification should take no more than 30 seconds to apply, pose no undue risk to the operator and cause minimal discomfort or danger to the animal.
- The means of identification used should not cause pain or discomfort to the animal once it is in place.
- Identification must be readily readable from a distance of 1–2 m in the case of cattle and buffalo, and from a distance of 0.5–1 m in the case of smaller livestock. Ideally, it should not take more than a few seconds to read the identification (visually in the case of alphanumeric symbols or electronically in the case of bar codes or transponders).
- The means of identification used should be of uniform make and quality, and should be produced by means that reduce the possibility of forgery or unauthorized duplication.
- Ordering and distribution of identification devices must be centrally controlled by an institution mandated to register livestock identification to reduce the possibility of unauthorized or fraudulent use of existing identification codes.
- The means of identification used must be tamper-resistant in that it must not be possible to remove an installed identification from an animal without damaging it so as to render it unusable and unable to be transferred to another animal.
- Means of identification should be durable, have a high retention rate and be clearly readable for at least seven years after application. Ideally, a retention rate of over 90 percent is desirable, and any identification system should make provision for the replacement of lost or damaged identification devices.
- Identification codes shall be in alphanumeric form for ease of recording.
- Farmers should keep records of livestock and their identification codes on their farm.

SPECIFICATIONS VERSUS STANDARDS

Standards are intended to be a generic and minimum set of rules to which the identification method must conform. The set of standards above could apply equally to visual tags, bar-coded tags or subcutaneous RFIDs.

Once the registering body has been established and begun to evaluate local conditions and needs, the time comes to decide on the specific identification mechanism to be used and to describe the device exactly so that manufacturers know what to supply. It is entirely possible that an identification system in a developed country might give farmers a number of options to choose from, while in a developing country with more economic constraints, there might only be one option.

The set of specifications describes in some detail exactly what the device should look like in terms of size, shape, colour and (where appropriate) electronic performance parameters (Box 3.3).

In the case of national livestock identification being made compulsory, legislation should be drafted (Box 3.4).

Box 3.3 **Example of visual ear- tag specifications**

- Dual (male and female) leaf-type tags; yellow in colour; black laser printing on tags (Photo 3.5).
- Male tag smaller (printed section of tag approx 55x20 mm); for application on outside (caudal surface) of ear.
- Female tag larger (printed section of tag approx 55x35 mm); for application on inside (cranial surface) of ear.
- Male component to bear the scheme logo and alphanumeric codes identifying farm of origin (font 10 mm high) and serial code to identify individual animal (font 8 mm high).
- Female component to bear scheme logo and an alphanumeric code identifying the farm of origin (font 10 mm high) underneath which there shall be a space 25x55 mm to provide for information to be added by the producer as necessary.
- The farm identification code shall not exceed 11 characters and the animal identification code shall not exceed 5 characters.
- The codes used shall be the codes used in the scheme identification database.
- The male and female tag components shall be joined when the tag is applied to the ear by a suitable applicator, by a locking device so that the two components cannot be separated without causing physical breakage of one or both tag components.

Box 3.4 **Animal identification legislation**

Drafting of legislation should be done in two parts:

- An Act of Parliament, which would define identification, the species to be identified, the parts of the country where the legislation would apply, create the central authority and define its powers, and define felonies. The Act would empower the responsible Minister, in collaboration with the central authority, to make regulations.
- A set of Regulations, to be promulgated by the Minister designated by the parent Act, which would precisely define the means of identification to be used, and make provision for all the mechanisms needed to administer and enforce identification.

A legal framework of this type enables changes to be made to the identification system through referral to a Minister only, without having to place an amendment before Parliament. This enables the system to be flexible and responsive.

• Checklist of relevant actions for the implementation of livestock identification •

Animal identification schemes are usually initiated by private organizations - farmers' unions, abattoir associations, marketing organizations and the like. The first step would involve investigating the requirements of the market to be served and the reasons for which identification is desired. Thereafter, the farming community must be assessed in terms of its willingness and ability to implement good identification practices.

Based on these findings, a suitable scheme can be devised. In seeking to create a Registering Body for Livestock Identification, consideration should also be given as to whether such a scheme should be compulsory or voluntary. A compulsory scheme may require the writing of appropriate regulations and the involvement of the relevant government departments.

Considerable time will also have to be spent on publicity and training in order to make such a scheme successful.

A checklist of activities to be undertaken in implementing an identification programme is shown below.

ACTIVITY	✓
Assessment phase:	
Market needs	
Farmer abilities	
Initial design proposals	
Planning:	
Identification and involvement of stakeholders in planning	
Identification standards	
Registration and control (including software design)	
Logistics of distribution	
Specification of devices	
Cost implications and cost-bearing	
Central registering body - structure, functions, resources	
Drafting of legislation/registration (if necessary)	
Awareness and training:	
Formulation of publicity message	
Undertake publicity campaign through relevant media	
Identify categories of people to be trained:	
- farmers	
- extension workers	
- distribution network	
- other	
Creation of appropriate training materials	
Set training dates, venues and execute training	
Implementation phase:	
Set implementation date	
Finalization of necessary software, purchase of equipment	
Creation of registration body	
Creation and testing of register	
Tender for device manufacturers, appoint manufacturers	
Begin registration process, ordering and distribution of identification devices	
Monitor progress	

Summary

- The two main reasons for having a system of livestock identification are proof of ownership and traceability/management facilitation. The requirements and type of identification used for these two goals differ.
- Means of identification currently used include:
  - **Branding and tattooing as marks of ownership.** These two methods suffer severe disadvantages in terms of readability and control over their application and use. They are thus unusable for traceability or management purposes.
  - **Various forms of ear tagging using visual codes, bar codes or transponders.** Advances in tag manufacturing technology have made tags a reliable and now popular form of identification.
    - Bar coding and transponders require the use of scanning equipment, which makes their use expensive.
    - Transponders may also be used subcutaneously or internally.
- Basic requirements for an identification system include:
  - clear readability of the identification device;
  - central control over the production, allocation and distribution of identification devices;
  - devices must be difficult to counterfeit and be non-transferable (tamper-resistant);
  - devices must be durable, cost-effective and easy to apply;
  - devices should not cause pain or discomfort to the animal.
- In developing countries, visual tags are often the devices of choice.
- A livestock identification system must have a central registering authority with the following functions:
  - registration and allocation of identification codes;
  - keeping of a register of codes, and the farmers, holdings and animals to which they have been assigned;
  - standard-setting for animal identification.
- There is a difference between standards and specifications for identification:
  - standards refers to a set of criteria which must be met by any device used by the system;
  - specifications refers to the exact appearance and performance of the device (which must meet the standards).
- Animal identification as to the place of origin should be maintained.

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SECTION 4

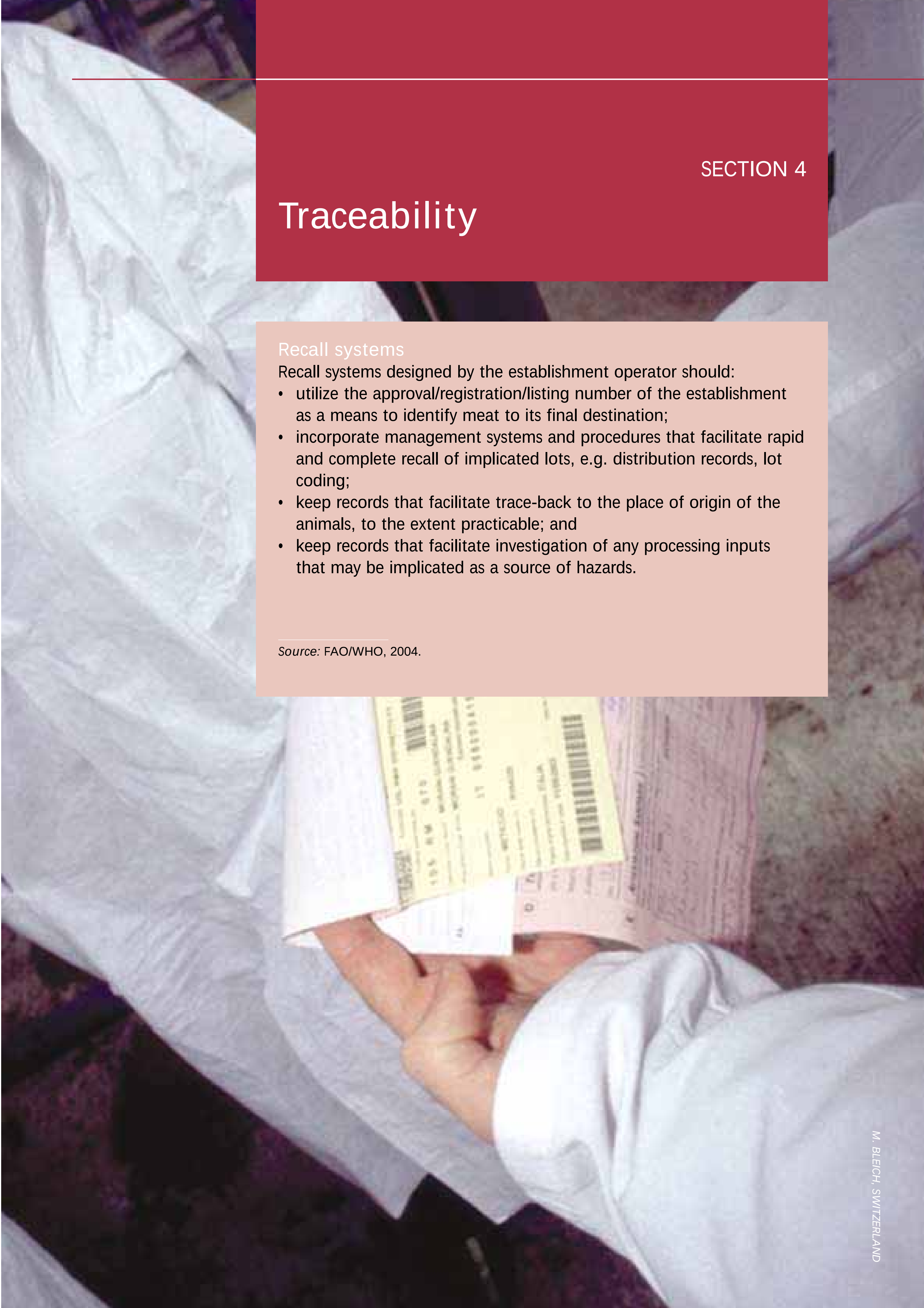
Traceability

Recall systems

Recall systems designed by the establishment operator should:

- utilize the approval/registration/listing number of the establishment as a means to identify meat to its final destination;
- incorporate management systems and procedures that facilitate rapid and complete recall of implicated lots, e.g. distribution records, lot coding;
- keep records that facilitate trace-back to the place of origin of the animals, to the extent practicable; and
- keep records that facilitate investigation of any processing inputs that may be implicated as a source of hazards.

Source: FAO/WHO, 2004.



M. BLEICH, SWITZERLAND

INTRODUCTION

The need to trace an animal and its products as they progress through the production chain was initially occasioned by the appearance of human health risks derived from livestock – bovine spongiform encephalopathy (BSE), *Escherichia coli* food poisoning , residues derived from substances administered to animals on the farm, etc.

However, the pressure for traceability rapidly mounted as consumers demanded to know more about the animals from which their food was derived. It became more than a health issue – consumers needed to know more about the circumstances under which animals were raised, how they were transported, how they were slaughtered – in summary, a host of events along the production chain were of interest and had to be traced.

Traceability is now no longer purely a health issue, but a marketing tool designed to give the consumer assurance that the product he/she is consuming is both safe and ethically acceptable.

Thus arose the need for reliable and easy identification of the animal and a paper trail showing clearly where the animal had been and to what practices it had been subjected. Furthermore, the animal had to be linked to its products, meaning, for example, that the carcass and the meat cuts derived from it in an abattoir had to be identified and linked to the live animal from which they originated.

Traceability has been given many definitions and traceability techniques have been developed for everything from motorcar parts to vegetable soup. For the purposes of this publication (which concentrates on livestock), traceability will be defined as the ability to, and the mechanisms designed for, the tracing of an animal product along all steps in the production chain back to the holding of origin of the live animal from which the product was derived .

WHAT IS A TRACEABILITY SYSTEM?

A traceability system consists of a series of interlocking elements linked by an auditable paper trail and quality-controlled by a series of inspections or audits. Any item moving from one element of the system (or chain) to another must be identified by an identification code or number, and each movement into and out of any given element in the chain is recorded using the item's identification number.

In the case of animals, each animal must be clearly and unambiguously identified and, as it moves along the production chain, its identification code or number must be recorded at each step as proof that it has passed that way. A trace-back audit must be able to verify not only the path that it has travelled, but also that circumstances at each step in the chain have met certain standards. An animal may move from its holding of birth to an auction, then on to a fattening farm and finally to an abattoir. In this case, the date of entering and leaving each place must be recorded using the animal's identity code. Additionally, there must be sets of rules governing the management at each of these places (farms, auction pens and abattoirs) whose implementation can be verified by inspection.

Traceability schemes usually have a central controlling body that: issues identification codes and sets standards or codes of conduct for each link in the production chain; has an accreditation system that ensures that all role-players conform to acceptable standards of management; and operates inspection and audit systems to verify the functioning of the system.

COMPONENTS OF A LIVESTOCK TRACEABILITY SYSTEM AND THEIR ROLES/FUNCTIONS

Controlling body or bodies

A traceability system needs a central controlling mechanism or mechanisms to carry out the following basic functions:

- setting of identification standards and specifications and issuing of identification codes to livestock producers for application to their animals via the specified identification devices;
- setting of standards for the various role-players in the system, i.e. farmers, transporters, traders, abattoir companies, and the accreditation and inspection of these role-players;
- the central recording of all movements of animals belonging in the system and, where

necessary, the follow-up and verification of these movements.

It is not necessary that all the above functions be vested in one controlling body; indeed it may be desirable to split these functions among more than one body so that a measure of cross-checking occurs within the system.

The registration of animal identification codes and their cross-referencing to owners and farming properties are of prime importance and go hand in hand with the register of farms/holdings (see below).

Register of participating farms/holdings

As alluded to above, there needs to be a register of accredited farms or holdings. These are farms whose management practices have been approved by the scheme through a suitable inspection and reporting system. The holdings must be inspected regularly by an inspectorate that will update the register as necessary. There needs to be a clearly stated set of standards or code of conduct to which these farms must conform; where farms fail to conform, their marketing privileges should be suspended until the shortcomings are corrected.

A key element (but not the only one) of the standards to be maintained is the reporting by farmers of the movement of animals to and from their farms.

Other registers

Accreditation standards and registers of approved organizations must also be set up for:

- livestock transporters;
- livestock marketing agents or traders;
- abattoirs.

The implementation of these standards should be monitored by the same inspectorate that monitors farm standards. Apart from the obvious health and welfare standards, these organizations and individuals should be required to keep a register of movements based on the identity codes of the animals with which they deal, and to submit regular reports on these movements to a central controlling authority.

Animal identification and backup measures

An animal identification scheme must be in place, under the control of a centralized body that sets standards, allocates identification codes and controls the distribution of identification devices specified for use by the traceability system. Careful records must be kept of the identification codes issued – to whom, on which property and for which animal/s.

Identification devices must comply with certain minimum standards with regard to readability, tamper-resistance and safeguards against fraud.

The most straightforward system uses group identification and traces back only to the farm of origin immediately prior to slaughter. All animals will wear the same identification code; should an identification device be lost, it is easily replaced with another of the same type.

Most systems are more complex than this; animals are uniquely identified by the farmer at birth, weaning or just before leaving the farm. The farmer must keep a record of the identification numbers issued, together with a rough description of the animals thus identified; he/she must also notify the central authority of these identifications so that they can be centrally registered.

This type of identification – individual identification – assigns a unique identity number to each animal, which it will keep throughout its life. The animal thus keeps its own identification device from early in its life until it is slaughtered. If it moves to another farm, the new owner must notify the central registry that the animal (identified by its unique number) has come into his/her possession.

Given that the animal will keep its identification for a considerable period of time, a backup system is needed, should the identification be lost. What will happen if an ear tag is lost, or if a microtransponder malfunctions?

One way to handle such a situation would be to have a detailed description of each animal kept on file. If an animal loses its identification, its code could be found by looking up its description, and a duplicate identification device could then be requested by the owner. However, such a procedure would add enormous complexity to the system, as a database containing complete and detailed descriptions of each animal in the system would have to be kept.

The best way to handle such a contingency would be for each animal to carry a small secondary identification device: if the main device were lost or malfunctioning, there would be a backup available. In Europe, cattle are tagged in both ears with tamper-proof plastic tags. A cheaper option would be to place a large and readable primary tag in one ear, and a small metal tag (unreadable except at very close quarters) in the other ear. Upon loss of the primary tag or microtransponder, the owner would read the animal's identity number from the secondary tag and file a request to the registering authority for a duplicate primary identification device.

Traders and transporters

Livestock trading agents, auctioneers and transporters have an important role to play as links in the production chain, even though their contact with the animal may be short-lived. They would have to:

- put in place a bookkeeping system with detailed records of all animals passing through their hands (identification numbers and dates of transactions at the very least);
- regularly notify (on a weekly or monthly basis) the central authority of all animal movements both into and out of their enterprises;
- maintain animal welfare standards in terms of the facilities they use, animal management, vehicle standards and acceptable driving practices.

Abattoirs

Abattoirs would be responsible for keeping records of all arrivals, and for notifying the central authority of arrivals and slaughterings so that slaughtered animals could be recorded as having been terminated and no longer in the system.

Abattoirs would also have to monitor the identification of animals carefully so that animals coming from farms that had lost their accreditation were rejected and not slaughtered. Records of such rejections would also have to be kept, and the central authority notified.

Abattoirs would have to adhere to a code of conduct in terms of animal welfare (facilities, handling, humane slaughter) and hygienic practices inside the abattoir.

TRACING OF LIVESTOCK MOVEMENTS THROUGH A TRACEABILITY SYSTEM

The role of the central authority

The work of the controlling authority is central to the success of a traceability system. Each movement of an animal through the system, together with the animal's identification number and the date of the movement, must be recorded. Movement recording of groups of animals is less voluminous than recording of individuals, but both types of system will require a computer database that keeps details of all movements. For a sample set of specifications for such software, see Box 4.1.

The role of the livestock owner

The livestock owner has a twofold role with respect to the system:

- allocation and registration of new identities;
- recording and reporting all movements to and from the farm/holding.

There are various options for the timing of assignment of identification codes to individuals. When a farmer orders a set of identification devices, his/her order is recorded by the central authority and the farmer is then responsible for the allocation of these devices to individual animals. He/she must then report such allocations to the central registry. The timing of allocation of identity numbers to animals may be:

- At birth: in farming systems where there are small numbers of animals involved, or that are intensive or semi-intensive, this is feasible.
- At weaning: in extensive systems where animals are usually handled at weaning for the purposes of vaccination and dosing, this would be a better time for the application of identification devices and reporting allocations to the central registry.
- On leaving the farm: where cost-saving and administrative simplicity are important, this would be the best time for assigning animals their identification codes. Only animals that move need be traced; thus, strictly speaking, only those that leave the farm need be identified.

The traceability scheme would spell out rules in respect of the above, and it would be the farmer's duty to abide by these rules. For ease of administration, a farmer would best be required to report on such registrations at regular intervals (say monthly) by completing a registration record and sending a copy to the central registry. For an example of such a report, see Box 4.2.

Once an animal or group of animals leaves the farm for another destination, the farmer has to keep a record of the date of the transaction, as well as the identification numbers of the animals that have been moved from the farm. The central authority would also have to be informed, so that the movement could be recorded on the central register of movements.

There are a number of options for tracking and recording such movements. These include:

- **Option 1.** Animals retain their original ear tag lifelong. When change of ownership occurs, the owner completes a change-of-ownership document (on paper or by Web access or e-mail) for submission to the central registry, giving the date of the transaction and the name of the new owner.
- **Option 2.** Animals retain their original ear tag lifelong. Each animal has a passport that accompanies it; original and new owners complete change-of-ownership notices (paper/Web/e-mail). In Europe, the chequebook-type passport has removable pages that are used as change-of-ownership notices.
- **Option 3.** Animals retain their original ear tag lifelong. Old and new owners complete registers of arrivals and departures on a monthly basis, which are submitted to the central registry (paper/Web/e-mail) each month. See Boxes 4.3 and 4.4 for examples of such registers.

By ensuring that each person in the chain records arrivals and departures, every animal movement is recorded twice; thus there is a double-check on each movement. The disadvantage of these systems is that there is a time lag between the time that a movement takes place and the time that it is centrally recorded. There are thus always a number of animals floating in the system. However, as long as farmers recorded movements immediately on their own on-farm registers,

BOX 4.1 **Movement tracking software at the central registry - sample software specification**

1. The software will be Internet-based and allow access by users from all over the country against a password. Data input may be by remote users (where possible) or by registry staff.
2. The database will be hosted by the central registry and managed from its servers.
3. The database will include data on:
   - properties: name, number, district, linked to producer/s on each property;
   - producer: name, personal ID number, postal address, telephone + fax, e-mail;
   - property identification codes as linked to properties and producer;
   - characteristics of livestock belonging to the producer:
     i. individual identity number (i.e. ear-tag number)
     ii. birth date
     iii. sire and dam (where available/appropriate)
     iv. performance data: birth mass, weaning mass, 18/24-month mass, slaughter mass and grade, date of slaughter/death, diseases, treatments (where available/appropriate).
4. The software will make provision for the recording of individual movements to other properties, auction pens and abattoirs, and the tracing of such movements through the appropriate queries. Additionally, the software shall make provision for ownership changes so that the animal with its ID is attached to a new owner, and each of these movements/changes of ownership shall be recorded in the database with the date at which each transaction occurred.
5. The software will be directly linked to abattoir tracing software such that a query made regarding a traceability code on a meat package will lead directly to the farm(s) on which the animal stayed during its life. Slaughter mass and grading data will also be transmitted from the abattoir to the central registry.

BOX 4.2 **Example of notification of allocation by farmer of identification devices**

NOTIFICATION OF REGISTRATION (TAGGING) OF BOVINE(S)

To be completed at the end of each month and forwarded to the Scheme Administration, PO Box 38, Blikkiesdorp. info@blikkies.com http://www.blikkies.com/ID

Producer name:	Producer code:
Year:	Month:

Date of birth dd / mm / yy			Ear-tag no.	Sire (Ear tag no.) (if available)	Dam (Ear-tag no.) (if available)	Sex (M/F)	Breed	Birth mass (kg)

BOX 4.3 **Example of departures register**

To be completed at the end of each month and forwarded to the Scheme Administration, PO Box 38, Blikkiesdorp. info@blikkies.com http://www.blikkies.com/ID

Producer name:	Producer code:
Year:	Month:

Full ear-tag number	Moved to District	To farm (name/number)	New owner	Veterinary movement permit number	Date of movement

BOX 4.4 **Example of arrivals register**

To be completed at the end of each month and forwarded to the Scheme Administration, PO Box 38, Blikkiesdorp. info@blikkies.com http://www.blikkies.com/ID

Producer name:	Producer code:
Year:	Month:

Full ear-tag number	Arrived from District	From farm (name/number)	Previous owner	Veterinary movement permit number	Date of movement

there would always be a means of tracing movements between farms in the event, for example, of an outbreak of contagious disease.

Many countries have a veterinary movement control system that controls the movements of groups of animals from one place to another through the issuing of movement permits. Endorsing the identification codes of moved animals on these permits would provide a further backup mechanism for movement tracing.

The role of traders and transporters

Agents and transporters would have to keep their own registers of movements of animals into and from their enterprises; records similar to the arrivals and departures registers, or tear-outs from passports would have to be submitted to the central registry so that the movement of each animal or group of animals would be recorded against a date and their identification codes.

The role of abattoirs

Abattoirs need to maintain their own in-house tracing systems so that a package of meat or a carcass can be traced back to the animal, or at least to the group of animals, from which it originated. Recording times of deboning or packaging would allow trace-back to the slaughter of the original consignment of animals provided that the time from slaughter to packaging was constant and known. Such time-based systems are common, but a carcass marking system is far better.

Each carcass should be assigned a number immediately after bleeding-out and skinning, which should be recorded on a computer system; when the carcass is weighed and graded, this information could be recorded against the carcass number. If meat is deboned and packaged (i.e. mixing of meat from various carcasses occurs), the numbers of the carcasses in the consignment that is deboned must be recorded so that at least the batch numbers of the meat packages can be matched to a consignment of animals.

Ideally, the number assigned to the carcass should be recorded in the abattoir's system against the identification number of the live animal so that the abattoir traceability system is seamlessly linked to the field traceability system. In theory, a farmer should be able to query the traceability system to ascertain the slaughter weights and grades attained by each animal he/she consigned for slaughter.

Legislation and codes of conduct

Where a traceability system is obligatory at national level, appropriate laws or regulations are needed, and an institution must be designated as the enforcing authority.

In many countries, traceability schemes are voluntary and involve a group of farmers serving a particular market. In such cases, the scheme must have its own internal rules and farmers, agents, transporters or abattoirs not complying with these rules must be excluded from the specific market.

OVERALL SPECIFICATIONS FOR A TRACEABILITY SYSTEM

The first decision to be made when planning a traceability system concerns the level of definition to be used by the system. Tracing groups only means that herds are given single identity codes and that when the group is moved (e.g. sent from the farm to the abattoir) a single identification code is used in recording the movement, and all animals in the group will bear the same code.

In practice, group identification presents problems, especially when animals from different groups are mixed (e.g. a transporter moves animals from several farms to an abattoir). For this reason, many traceability schemes opt for individual animal identification. The specifications given here are proposed for individual identification.

The aim of the traceability system should be to provide for trace-back of a meat from the packaged product to the premises of origin so that the origin and cause of defects may be traced, and also to provide for forward tracing from any point in the production chain so that a batch of products can be recalled, if necessary. The system should further ensure that only products originating from approved role-players in the production chain can enter the market, and provide for the exclusion of products from non-approved sources.

- The traceability system should be under the control of one or more central authorities that will formulate and enforce the standards and rules of the system.

- Animal identification should be under the control of a central authority that will control the allocation and distribution of identification codes and identification devices.
- Animals should be individually identified with devices that are safe, tamper-resistant, fraud-protected and adhere to certain standards, and are thus uniform in appearance and quality.
- The scheme should make backup provisions in case of loss of identification devices.
- Animal identification codes should be quoted in the recording of all movements and transactions within the scheme.
- The scheme should make provision for the recording of movements of animals along the production chain from birth through finishing to the abattoir.
- The allocation of identification codes to animals is the responsibility of the producer who should regularly report details of such allocations to the central authority.
- The scheme should provide for standards to be adhered to by all role-players in the scheme, and should operate an accreditation mechanism to allow participation in the scheme.
- Adherence to scheme standards should be monitored by regular inspections carried out by an inspectorate accredited to the scheme.
- The scheme should ensure that traceability of animals in the field is linked to traceability within abattoirs.

• Checklist for the implementation of a traceability system •

Animal identification and traceability go hand in hand, and those responsible for initiating modern systems of identification are usually also those who take the lead in setting up traceability systems, i.e. private sector role-players.

For this reason, the initial steps to take in setting up traceability schemes would be the same as for identification systems. Market and regulatory requirements would have to be balanced against the abilities of the farming community, agents, transporters and abattoirs in order to assemble a workable scheme.

A registering/controlling body would have to be created, and its exact responsibilities and resources defined. The creation of one or more controlling bodies might also be contemplated, or a government department or agency might be able to take on some of the control functions required by the scheme. Thought would have to be given to the issue of whether a voluntary or compulsory scheme would be appropriate.

Detailed and careful consultations would be needed in designing the scheme, the responsibility for which would lie with the controlling institution. Considerable time would have to be invested in publicity and training, given the complexities of administering the system.

A checklist of tasks to be undertaken in assembling a traceability scheme follows.

ACTIVITY	✓
Assessment phase:	
Market needs	
Farmer abilities	
Initial design proposals (taking identification system into account)	
Planning:	
Identification and involvement of stakeholders in planning	
Scheme standards and procedures	
Registration and control (including software design)	
Logistics of implementation, recording, reporting	
Specification of administrative procedures	
Cost implications and cost-bearing	
Central controlling/registering body - structure, functions, resources	
Drafting of legislation/registration (if necessary)	
Awareness and training:	
Formulation of publicity message	
Undertake publicity campaign through relevant media	
Identify categories of people to be trained:	
- farmers	
- extension workers	
- agents/traders/transporters	
- abattoir staff	
Creation of appropriate training materials	
Set training dates, venues and execute training	
Implementation phase:	
Set implementation date	
Finalization of necessary software, purchase of equipment	
Creation of registration body	
Creation and testing of traceability procedures, computer system	
Begin registration processes, recording of movements	
Monitor progress	

Summary

- The need for animal traceability began with the emergence of various food-borne diseases and the need to control the entry of harmful residues into the food chain; it has now evolved as a marketing tool to enable consumers to be certain that purchased food items originate from production practices that are safe and morally acceptable.
- A traceability system allows for the identification and tracing of a given item as it moves through a production chain from start to finish.
- Conditions at each point in the chain must satisfy certain minimum standards and be monitored by a system of regular inspections.
- There must be a central authority or authorities controlling the traceability system/scheme.
- Aspects requiring central control include:
  - standards for identification, and the issuance of animal identification codes to producers;
  - codes of conduct for role-players, and the accreditation and inspection of role-players and their activities (this includes farmers, traders, transporters and abattoirs);
  - movement recording and tracing/verification.
- These controls could be assigned to a single body, or split among two or three controlling authorities to enable cross-checking.
- There must be a register of accredited farms/holdings linked to a register of animal identifications allocated to these holdings.
- Other role-players such as traders, transporters and abattoirs must also be registered with the traceability scheme.
- Animal identification must be safe, readable, fraud-protected and tamper-resistant.
- Provision must be made for loss of identification devices.
- Producers must record each application of an identification device and report these to the central authority on a regular basis.
- Producers must record all movements to and from their farms and report these transactions (with dates and identification numbers of animals involved) to the central authority.
- Other role-players involved with movement of animals along the chain of production (traders and transporters) must record all transactions (giving dates and animal identification codes) and report these regularly to the central authority.
- Abattoirs must record details of all arrivals and report these to the central authority. The identification of animals must be linked to the identification of carcasses so that tracing is possible from the meat to the animal or group of animals from which it was derived.
- Holdings or farms that have lost their status within the system must be recorded and any animals that originate from such farms must be denied access to slaughter facilities.
- Provision must be made for legislation to enforce the system (where it is obligatory on a national basis); otherwise those who break the rules of a voluntary scheme must be denied marketing rights.
- Traceability requirements are increasingly seen as means of gaining and maintaining market access. Countries may apply traceability criteria to imports provided that these do not exceed requirements applied at the domestic level.

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SECTION 5

Transport of slaughter animals

Transport of slaughter animals

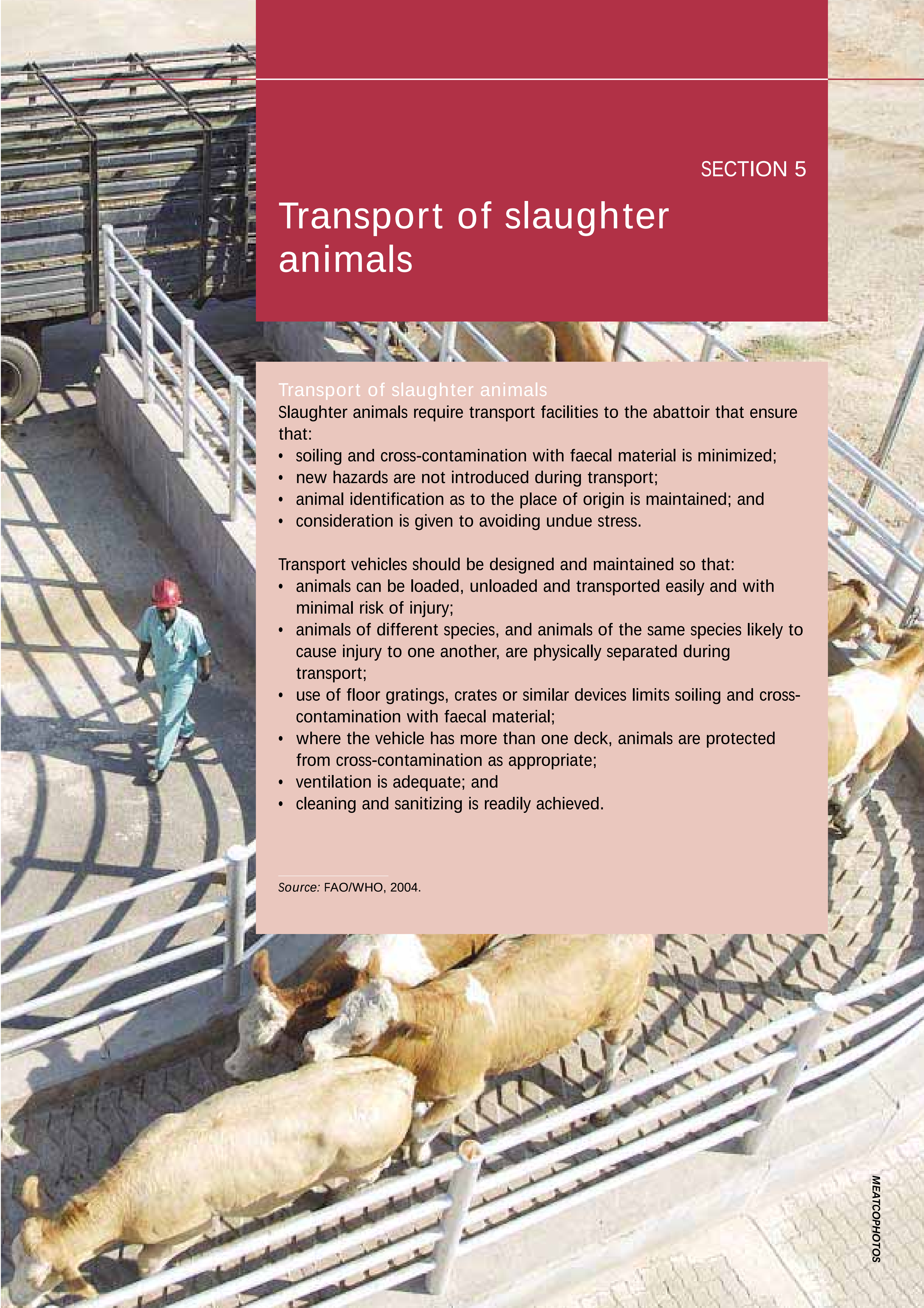
Slaughter animals require transport facilities to the abattoir that ensure that:

- soiling and cross-contamination with faecal material is minimized;
- new hazards are not introduced during transport;
- animal identification as to the place of origin is maintained; and
- consideration is given to avoiding undue stress.

Transport vehicles should be designed and maintained so that:

- animals can be loaded, unloaded and transported easily and with minimal risk of injury;
- animals of different species, and animals of the same species likely to cause injury to one another, are physically separated during transport;
- use of floor gratings, crates or similar devices limits soiling and cross-contamination with faecal material;
- where the vehicle has more than one deck, animals are protected from cross-contamination as appropriate;
- ventilation is adequate; and
- cleaning and sanitizing is readily achieved.

Source: FAO/WHO, 2004.



MEATCOPHOTOS

INTRODUCTION

The transport process is part of the series of events required to get the animal from farm to slaughter, which is usually referred to as pre-slaughter or ante-mortem handling. Pre-slaughter handling may be very stressful to animals and can lead to significant losses in the quality of the final product if carried out without the necessary care. Under very poor conditions animals may die. This can occur through overheating as a result of poor ventilation, particularly in poultry and pigs; through stress leading to heart failure; or through trampling and suffocation, especially in large cattle. Animals may suffer dehydration through lack of adequate water provision. They may suffer exhaustion or fatigue through prolonged food deprivation and the rigours of keeping their foothold. Slips, falls and bumping into sharp projections on the walls of pens, races or vehicles can lead to bruising and other kinds of trauma such as internal haemorrhages and broken bones. Trauma may also be caused by fighting between unfamiliar or non-compatible animals. This is especially a problem in pigs and adult cattle. The presence of horns can make the injuries considerably worse. Animals may suffer from the heat if they are not protected from strong sunlight. Pigs with white skins may suffer sunburn. Trauma leads to poor welfare and reduced carcass value, and can also damage hides and skins.

Stress can lead to the production of poor-quality lean meat. In pigs, relatively short-term stress may produce pale, soft, exudative (PSE) pork. As its name suggests, this is pale and unattractive in colour, and loses a large amount of water as drip or exudate. In all species, longer-term stress may produce dark, firm, dry (DFD) meat. This is particularly a problem in cattle, where it is often referred to as dark cutting beef (DCB). As well as having an unattractive appearance, it is more prone to bacterial spoilage than normal meat.

INSPECTION OF ANIMALS FOR FITNESS TO TRAVEL

For reasons of hygiene and welfare, animals must be fit to travel and to this end, they must be inspected by a competent person immediately before loading. Animals suffering from contagious diseases can spread infection widely if transported. Animals that are ill or injured are not fit. Unfit animals include those that:

- are in pain, or would suffer pain if transported;
- cannot walk normally;
- are lame;
- have broken bones, or large or deep wounds;
- have prolapses of the rectum or uterus;
- are pregnant females near to the time of giving birth;
- have given birth in the previous 48 hours;
- are newborn or very young animals.

Preparation for transport or movement

Before transport, animals should be held in appropriate facilities where they have easy access to potable water and are protected from adverse weather. These facilities need to be well designed and carefully maintained to facilitate ease of movement and prevent injury to both animals and stock handlers. All facilities should have roofs to provide protection from rain, wind and sun. Outer walls should be solid in cold climates, but in hot climates may beneficially be constructed of open metal, wood or concrete rails to assist ventilation. The rails must be close enough to prevent animals getting their heads or legs trapped between them. For handling and moving pigs, solid-sided walls to a height of about 0.9 m are needed. The sides of cattle pens should be 1.6 m high. Floors must allow cleaning and be non-slip, for example by using textured concrete. Good drainage is essential to prevent pools of standing water that can distract animals, and so make them difficult to move, and can compromise hygiene.

Animals need enough space to rest. Appropriate floor area allowances per animal are:

- cattle 3 m^2
- sheep and goats 0.7 m^2
- slaughter pigs (weighing up to 100 kg) 0.6 m^2
- adult sows 1–1.5 m^2

Adult bulls and boars should be individually penned. Individually penned animals must have enough space to turn around and lie down comfortably. The time for which animals are held and without food should be kept to a minimum commensurate with hygiene and welfare requirements. However, pigs should not be fed within four hours of loading since full stomachs can make them travel sick and may increase the chance of them dying during the journey. Feed must be sufficient and provided in suitable mangers or troughs as appropriate. Incompatible animals must be kept in separate pens.

METHODS OF CATTLE TRANSPORTATION

The most appropriate methods of moving cattle are on hoof (Photo 5.1), by road motor vehicle (Photo 5.2) or by rail wagon (Photo 5.3). Moving cattle on the hoof (trekking) is suitable only where road and rail infrastructure does not exist, or when distances from farm to destination are short. This method is slow and fraught with risks to the welfare and value of the animals. Rail transport is useful for short-haul journeys where loading ramps are available at railheads and transportation is direct to the destination. Road motor transport is by far the most versatile method of first choice and the most user-friendly. The remainder of this section primarily addresses road and rail transportation.

PHOTO 5.1
Moving cattle on the hoof

G. HEINZ, GERMANY

P. HEIMANN, FEDERAL VETERINARY OFFICE, BERNE, SWITZERLAND

PHOTO 5.2
Large trucks for transporting cattle

Journey lengths

Because transport is generally stressful to animals, transport times and journey lengths should be kept to a minimum and meat animals should be slaughtered as close to where they have been produced as possible. If the journey is prolonged, animals should be rested and watered, and if necessary fed, at intervals. Maximum appropriate journey times for every species are not well established. However, rest and water stops should be allowed at least every nine hours. This time may need to be reduced for young animals. Animals should be offered appropriate and sufficient feed at least twice a day and allowed sufficient time to digest it before the journey is continued. In very hot conditions, animals that are especially susceptible to heat stress, such as pigs, should be transported at night or in the cooler parts of the day. Vehicles need to be driven carefully, anticipating hazards and with gentle braking and acceleration, particularly on winding or poorly surfaced roads, to prevent the animals being thrown about, with the danger of injuries.

Loading and unloading

People handling animals should be skilled and conscientious stock handlers with an understanding of how to move animals using the principles of animal behaviour. Appropriate facilities should be available to avoid causing distress, injury or suffering to the animals and to protect human safety. Ideally, animals should not have to walk up or down ramps with slopes greater than 20 to the horizontal (1 in 2.75, or 4 in 11). It is better to use level loading docks, hydraulic loading platforms or hydraulically operated lifting decks on vehicles.

Pre-transport handling

Animals should be handled in such a way that they are subjected to minimum stress prior to transportation and are thus fit to travel with minimum risk of injuries. A rest period after mustering and handling before transportation is therefore essential. If mustering caused considerable physical exertion, it is desirable to feed, water and rest cattle close to the loading

P. G. CHAMBERS, ZIMBABWE

PHOTO 5.3
Rail trucks for transporting cattle

facility. Cattle that were exposed to unusual levels of contact with humans, dogs and motor vehicles should be provided with feed, water and rest for even longer periods.

Water and feed requirements

Deprivation of feed and water will compound the stress associated with transportation. However, if hungry and thirsty cattle consume large amounts of water and/or feed prior to travelling, then further stress may be caused. Some suggested feeding, watering and resting periods prior to loading are shown in Figure 5.1.

Shelter

Cattle should be protected from extremes of heat, cold and wind. In determining the need for shelter, environmental conditions, geographic location, breed and type, body condition and degree of acclimatization of cattle should be taken into account. Appropriate cattle shelter and handling facilities are discussed in Section 2.

Special cases

Injured or weak animals may be transported on veterinary advice. Where veterinary advice is not readily available, the decision may be made by an experienced person. It is preferable that cattle should not be allowed to become so weak that they are not fit for travel (Box 5.1). Animals that go down after limited exercise are not fit to travel.

Weakened cattle should be transported to their destination by the quickest, least stressful route. They should be given special protection against the extremes of weather. They should only be transported with cattle in a similar condition.

Supervision

The people responsible for the transport of cattle have legal responsibility for their care and welfare. Injuries and stress are most likely to occur during loading and unloading where facilities and handling practices are unsatisfactory. The loading procedure should be planned to allow adequate time for livestock to be loaded quietly and without causing them injury. Loading should be supervised by competent stock handlers who have a basic knowledge of the behavioural and physical needs of cattle. Supervisors should ensure that spectators or untrained assistants do not impede the smooth loading of animals. Unnecessary noise, harassment and force should be avoided.

Cleanliness

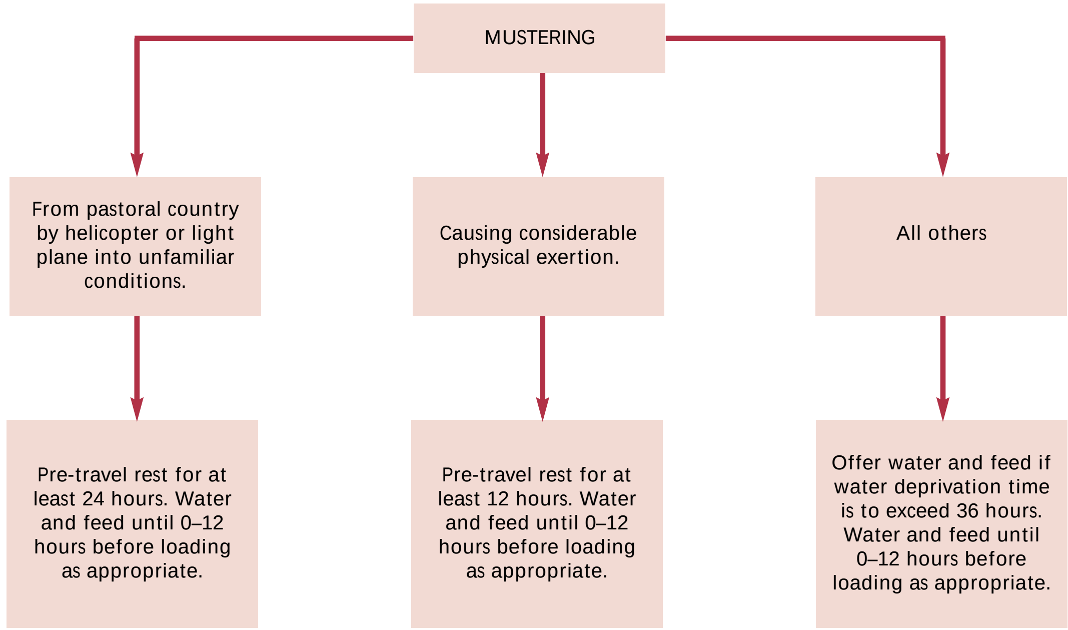
Cattle should be loaded on to vehicles or railway wagons with dry floors or floors that have been cleaned before loading. Appropriate construction methods should be used to prevent the soiling of animals on the lower deck of double-deck or multi-deck transport vehicles (see Section 2).

Handling facilities

Cattle will tend to follow each other unless they are distracted, and this behaviour should be exploited in the design of facilities (see Section 10). Sufficient area should be provided in forcing/receiving yards during loading and unloading to allow them to move freely in the desired direction. Movement can be helped by using curved races and fully covering the sides of ramps to provide visual barriers (Photo 5.4). Movement of cattle is also improved by providing clearly visible passageways and gateways (Photo 5.5). Cattle will behave defensively when confronted by visually contrasting surfaces such as shadows, gratings and surfaces that are uneven or steeply sloping (Photo 5.6).

Loading should take place from a properly constructed ramp or loading bay suitable for cattle, or an appropriate portable facility where a permanent loading ramp is not available. Yards should be constructed to avoid sudden changes in levels, steep slopes, dim and uneven lighting, narrow passages and sharp turns. Ideally, the area of the forcing yard should be sufficient to hold the transport pen size.

FIGURE 5.1 **Suggested pre-travel resting, watering and feeding time allocation for cattle mustered under different situations**



Source: Agriculture and Resource Management Council of Australia and New Zealand, 1999.

There should be no protrusions or sharp edges on the fences or gateways of the loading and handling facilities that are likely to cause injury to animals. Hinges and latches must not project into the pathway of animals. Gates should operate smoothly, retract fully from the pathway of animals, and not be susceptible to jamming. Gates should also be made clearly visible to animals when shut by providing, where necessary, a sight board to improve visibility.

Ramps should be constructed so that they are appropriate to the transport being used. Ideally, there should be a flat platform at the top of the ramp, level with the deck being loaded or unloaded. This should not be less than 1.5 m in length to aid the safe movement of animals. Ramps and walking surfaces should minimize the risk of animals slipping. Ideally ramp slopes should not be greater than one in five (20). Solid extensions must be used to cover any gap between the loading ramp and the floor of the stock crate and must not dislodge when in use.

PHOTO 5.4
***Good practice:* curved chute with solid sides and cattle moving in single file**

T. GRANDIN, COLORADO STATE UNIVERSITY, USA

Lighting

Artificial lighting is desirable for loading at night. Such lighting should be carefully positioned to give even light over ramps, races, yards and transport vehicles. Lighting should not cause deep shadows or bright spots in areas where animals move. The stock crate of the vehicle may also have diffuse interior lighting to help cattle see where they are going.

Segregation during transport

It is preferable that the following classes of livestock be segregated and transported in separate groups:

- horned cattle;
- hornless cattle;
- adult bulls;

PHOTO 5.5
GOOD PRACTICE: ***clearly lit raceway for cattle from pen to stunning area***

G. HEINZ, GERMANY

- cattle greatly different in size (cows and calves may preferably be transported together under some circumstances);
- weak cattle, which should be segregated from strong cattle.

Cattle should not be mixed with other species during transport. Working dogs should not be transported in the stock crate with cattle. Dogs should be transported out of sight of livestock in a suitably designed and ventilated kennel elsewhere on the vehicle.

Assisting the loading of cattle

Cattle are difficult to move unless they can see somewhere to go. The use of force on animals that have little or no room to move is cruel and must not occur. Electric prods should be powered only by battery and their use restricted to the amount necessary to assist the loading (Photo 5.7). Flappers (a length of cane with a short strap of leather or canvas attached) or metallic rattles are ideal in that they encourage movement in response to sound. Large sticks, lengths of metal piping, fencing wire or heavy leather belts must not be used to strike cattle. Canes or other materials used as an extension of the arm to direct cattle are a useful aid for handling.

The use of well trained dogs to help with the loading of cattle is acceptable. The number of dogs used should be the minimum necessary to complete the task. Manual lifting is permissible for young animals that may have difficulty negotiating a ramp.

Loading density

The livestock transport driver, after consultation with the owner, owner's representative or agent, is responsible for ensuring that the loading density and penning arrangements are compatible with the welfare of the cattle and the capacity of the transport vehicle. Loading cattle either too loosely or too tightly predisposes them to injury.

For road transport, traffic density in the areas where the trucks mostly operate should determine pen lengths, for example, 3–4.5 m when mostly in heavy density traffic and 6.1 m in other areas. The density of loading should be determined by the need to minimize injury but allow fallen animals to rise without assistance. It is accepted that different types of transport vehicles are used for livestock and that the transportation system has evolved to suit the husbandry system in each area. Acceptable loading rates will vary with the following factors:

- Loading densities are determined according to the average live weight, condition, size, shape and horn status of the cattle, as well as the prevailing conditions and the distance animals are to be transported. Loading rates must be assessed for each pen or division in the stock crate.
- Five percent fewer cattle should be loaded if they are horned.
- In hilly and more populated areas where road vehicles change speed more frequently,

Box 5.1 **More special cases**

The cases listed below would not ordinarily be part of a slaughter consignment but deserve mention:

- Cows that are more than eight months pregnant should not be transported. Where this is unavoidable they must not be transported for periods longer than eight hours owing to the increased risk of metabolic disease and injury. They should be offered water and food upon arrival at destination.
- Cattle that have recently given birth should not be transported until at least four days after calving.
- Lactating dairy cows should be milked at intervals not exceeding 24 hours.
- Calves are especially susceptible to stress, and care is required to ensure they are strong enough to withstand transportation.

T. GRANDIN, COLORADO STATE UNIVERSITY, USA

PHOTO 5.6
***Avoid:* obstacles to cattle movement. Clockwise from top left: non-solid wall with a visible car through the rail; litter in the chute; a hat and coat on the fence; shadows**

sufficient internal partitions must be used and numbers may have to be increased to prevent animals being thrown about.

- When fewer cattle than recommended loading densities per pen are transported, firmly fixed portable partitions should be used to prevent injuries during emergency stops.
- When more cattle than the recommended loading densities per pen are transported, fallen animals are unlikely to be able to regain their feet. The possible saving in freight from sending the extra animal, or animals, should be balanced against animal welfare considerations, potential product losses and mortalities.

Average recommended loading rates are given in Table 5.1.

Numbers above or below the recommendations will be appropriate in different circumstances. For example, variables such as breed, traffic density, road conditions and travel in double-deck transports have a major effect on loading densities, either alone or in combination. However, the welfare of cattle should not be compromised.

Offloading

Similar requirements to loading apply to the offloading of cattle, but it should be noted that cattle may be tired after a journey. Cattle should be unloaded as soon as possible after arrival at the destination. Injuries will be reduced if livestock are given the opportunity to walk quietly off the vehicle.

When unloading animals from rail or road transports, unloading banks (earthen mounds) are recommended. If such banks are long enough, several wagons or trailers can be unloaded at once. Where rail wagons have two doors, both must be dropped and secured in place before livestock can be offloaded, unless cattle are being offloaded down a single race or being transhipped from rail to road transport. Where sufficient pens are available, cattle unloading should avoid mixing of unfamiliar animals, which often causes fighting.

All cattle must be offered water as soon as possible after arrival at the destination. There is no justification for depriving cattle of water before slaughter.

The drover or transport driver should bring to the attention of the person in charge at the

TABLE 5.1 **Recommended average loading rates for cattle of various live weights**

Mean live weight of cattle (kg)	Floor area (m^2/head)	Number of heads per 12.2 m deck
250	0.77	38
300	0.86	34
350	0.98	30
400	1.05	28
450	1.13	26
500	1.23	24
550	1.34	22
600	1.47	20
650	1.63	18

Source: Agriculture and Resource Management Council of Australia and New Zealand, 1999.

destination any aspect of the journey that might affect the future welfare of the animals. This includes the last feeding and watering times and full details of any treatment given. The people in charge of the consignment should notify and transfer responsibility for the livestock to a suitable person at their destination. A system should be in place for delivery of cattle to abattoir premises outside business hours.

There should be facilities for the humane offloading or slaughter of animals that are unable to walk off because of injury or exhaustion. Severely injured animals must be humanely killed without delay. This should be done by, or at the direction of, the person in charge at the time if a veterinarian is unavailable. It is unacceptable to delay the humane destruction of severely injured animals. Animals requiring emergency euthanasia should be shot, or stunned and bled, without moving them further than is necessary. This may be on the transport vehicle.

IN TRANSIT

Behaviour of cattle

The behaviour of cattle during transportation should be taken into consideration in deciding on the mode of transportation, size of vehicle and the number and groups of cattle that will be loaded. Factors likely to influence security of balance during unsteady driving are the slipperiness of the floor surface and the availability of support from adjacent structures, including vehicle sides and partitions, and other animals. It may be advisable to withhold water during the last six hours before loading so as to reduce urination and have drier floors.

The major factors determining the well-being of cattle in road transport are vehicle design, stocking density, ventilation, the standard of driving and the quality of the roads. Resting periods with access to water are necessary when journeys exceed 24 hours.

Design of transport vehicle

Vehicles and their fittings must be strong enough to contain the animals and prevent their escape. The design of the crate must be such that cattle cannot jump out of the crate under normal circumstances.

The parts of the vehicle or wagon through which cattle move or in which they are held should be free from obstructions, projecting objects and hazards that could cause injury. Doors should be wide enough to allow easy exit

PHOTO 5.7
***Avoid:* electric prods (a)**
***Good practice:* where possible, alternative driving aids such as flags (b), plastic paddles or a stick with plastic ribbons attached to it should be used**

P.G. CHAMBERS, ZIMBABWE

T. GRANDIN, COLORADO STATE UNIVERSITY, USA and entry (no less than 900 mm). The space between decks should be sufficient for the cattle, including horned cattle, to stand in a natural position without contacting overhead structures. Materials used in the construction of transport vehicles must be able to be cleaned effectively.

The inside of livestock crates should be smooth and free of protrusions to minimize pressure points and reduce bruising. Spacing of side rails, where they are used, should be adequate to prevent the heads or legs of animals from protruding. Floor surfaces should provide a good foothold. The floor should be constructed from a non-slip material that will not injure the legs or hooves of animals. Ideally, stock crates should include provision to load/unload animals directly from the upper deck.

Vehicles should be serviced and maintained regularly to minimize breakdowns. The crate should be maintained in good working order.

The exhaust system of a vehicle must not pollute the air inside the stock crate. Sufficient gaps in the sides should be present to provide adequate air flow for the comfort of animals without overexposing them in cold conditions.

Responsibilities

Cattle should be transported to their destination as quickly as possible within legal requirements. Advance plans should be made to minimize any delay that could be stressful to the animals.

The primary producer should be responsible for the cattle until they are on the transport vehicle. They should then become the transporter's responsibility until they are unloaded. After delivery to an abattoir (including service abattoirs), abattoir management should assume responsibility until slaughter. When at sale-yards, they should be the responsibility of the manager, superintendent or supervisor of the sale-yard complex. When at a second property, the owner/manager of that property should be responsible for the cattle unless other agreements over responsibility have been made.

The driver must ensure that he/she is provided with the name and telephone number of the owner of the cattle, owner's representative or agent (whichever is appropriate) and of the consignee. The people organizing the transport of animals must be aware of any requirements for health certification and welfare of the animals and ensure that all legal approvals and documentation are completed before the commencement of the planned journey.

Owners' responsibilities

Primary producers have the greatest influence on handling and transport strategies. They decide which cattle are selected, how they are sorted and whether they are offered feed and water while they are in the sale-yard. They also set the rest/fast period prior to loading and the time the cattle are in the sale-yards from mustering to loading. They set the standards that affect their stock handlers' actions and also those of the transport drivers (Box 5.2).

Primary producers or their representatives have the responsibility to select and present only cattle that are fit for travel. The nature and duration of the proposed journey should be considered when determining the degree of fitness required.

The producer and transporter should ensure that those cattle most susceptible to stress or injury during transport are loaded last and unloaded first. The producer is responsible for the provision of well designed and maintained holding and loading facilities.

Livestock transporters' and drivers' responsibilities

Livestock transporters should establish effective liaison with experts on animal husbandry and welfare and consult routinely on the design, construction and maintenance of stock crates, existing or new rolling stock, livestock assembly yards and other facilities.

Responsibilities for road transportation

Drivers of road vehicles should be responsible for the care and welfare of the cattle during transport unless an attendant appointed by the owner travels with the consignment. Drivers must stop and assist a distressed or injured animal as soon as it is practically possible after they become aware of a problem. Drivers should be experienced in animal handling to ensure the welfare of cattle in their charge.

Learner-drivers should not be left to transport livestock without supervision.

Responsibility for rail transportation

The welfare of cattle is best safeguarded by a clear understanding and acceptance of the responsibilities of the owner, owner's representative or agent and railway staff during the various phases of transportation. Stockmen employed on trains should be competent in handling cattle, be required to complete trip reports, and have authority to delay trains in order to attend to cattle.

The owner, owner's representative or agent is responsible for:

- careful selection, loading and unloading of animals;
- the provision of competent stock handlers to load the livestock;
- loading livestock to railway schedules that will best avoid climatic stress;
- dealing with injured livestock or other emergencies when notified by the railway authority;
- ensuring water and stock feed are available at cattle rest stops;
- providing a stockman or livestock care system where appropriate, to care for larger consignments of livestock, especially on journeys longer than 24 hours, or to share the care for several small consignments;
- supervision of the unloading process and the final loading on to road transport (where applicable);
- ensuring that the livestock are rested after rail transport in preparation for any further travel;
- providing contact names and phone numbers for the owner, owner's representative or agent, as well as the person responsible at the destination.

The railway authority is responsible for:

- providing well maintained wagons appropriate for cattle;
- ensuring train drivers are aware that livestock have been loaded and of their location on the train;
- provision of accredited stock care managers at regular railway stopping points to inspect livestock and provide relief to sick and injured animals;
- taking care that materials carried in other wagons on trains do not affect the welfare of cattle, e.g. wagons containing dusty material placed in front of cattle wagons.

The owner of the loading and unloading facilities, including ramps, yards and watering points, is responsible for their maintenance.

IDENTIFICATION AND TRACEABILITY

Primary producers should ensure that all the livestock destined for slaughter are appropriately identified and farm records on the disposed stock are updated. Any person who transports livestock should ensure that they have at hand all documents relating to the identification of the stock they are transporting before the start of the journey.

HOLDING FACILITIES (LAIRAGE)

Premises that slaughter animals should have suitable facilities where animals can be held on arrival. These holding facilities, or lairages, can be covered, uncovered, purpose-built or, where appropriate, an open field. The essential design and operational features of a lairage are given below.

Box 5.2 **The importance of humane management**

Engineering and equipment is only one-third of the animal handling equation. Employee training and good management are the other two-thirds.

Observations on hundreds of ranches, feedlots and slaughter plants in the United States, Canada, Mexico, Australia, New Zealand and Europe indicate that the single most important factor which determines how animals are handled is the attitude of the manager. Operations with efficient humane handling and transport practices have a manager who is committed to animal care. Operations where abuse occurs almost always have lax management or management that does not care.

Source: Grandin, 1993.

- The design of the passageways and pens should be appropriate to the species of animal being handled.
- All structures and equipment should be well maintained, so that injury to animals is avoided.
- The holding facility should be designed to facilitate ease of handling, and all floors should be non-slip.
- Contrasts in colours and surfaces, e.g. the placement of drain covers or gullies on a concrete raceway, can make animals baulk and therefore should be limited in number or disguised.
- Passageways and pens for pigs should be solid-sided and not railed, to reduce visual distractions.

There should be sufficient lairage capacity to avoid problems with animals waiting on lorries/vehicles or overstocking of available facilities. This should take into account the need for extra space during a breakdown situation. The lairage should have suitable pens, equipment and procedures for the isolation and treatment of sick, injured or at-risk animals without causing further distress. Sick, fractious or injured animals should be accommodated and, if necessary, humanely slaughtered close to the point of arrival. Isolation pens should be kept well maintained and ready for their intended use. There should be no mixing of species, unfamiliar animals, adult and young animals (except in the case of cows and calves), horned/hornless cattle, adult male pigs and adult male cattle. Fractious animals should be penned separately to prevent them from injuring themselves or other animals. Lactating cows should be milked if held within the lairage for longer than 12 hours.

Holding facilities should provide a suitable environment with adequate ventilation and space to allow animals to rest, drink and where applicable consume food. All animals should have sufficient room to stand up, lie down (simultaneously) and turn around. There should be access to a dry lying area and a constant supply of clean water. Lairage facilities should provide protection from extreme conditions if appropriate for the species/breed of animal being held.

For most animal species there seems to be very little benefit to the animals in keeping them within the lairage for longer than one or two hours.

Movement to holding pens

Handling systems and procedures should be in accordance with animal welfare and behavioural principles. Animals should be handled calmly, quietly and firmly, with care to avoid unnecessary excitement or distress.

The lighting in all parts of the lairage should be bright enough so that animals can be inspected at any time by designated and competent personnel. The lairage should have drainage facilities for faeces and urine and the design should allow cleaning to be performed between batches of animals. The faeces and urine production of animals held in field lairages should also be considered. Noise from machinery, people and equipment should be kept to a minimum. Animals must never be hit, prodded or handled in such a way as to cause them unnecessary excitement, pain or suffering when moving them within the lairage. Pressure must never be applied to any sensitive areas, e.g. genitals, and the appropriate use of benign handling aids, such as pig boards, moving gates, bags and flappers, should be encouraged where possible.

Animals must not be kicked or their tails twisted or broken and they must not be lifted or dragged by their heads, horns, feet, tail, fleece or any other part of their body, or in any way that may cause them unnecessary excitement, pain or suffering. Electric goads or prodders should only be available as a last resort (when human safety may otherwise be compromised) and must only be used on the muscles of the hindquarters of adult cattle and adult pigs if they are refusing to move forwards and the way ahead is clear. Habitual use of electric goads should be viewed as a failure on the part of the stock handler to apply best practice and demonstrates a need for a review of the system and/or additional training. Experienced and competent stock handlers should be responsible for the way animals are handled in the unloading and lairage areas and their contribution to animal welfare should be recognized by managers.

Considerations in transporting livestock are summarized in Box 5.3.

Risks/hazards associated with transportation are outlined in Table 5.2, along with recommendations on how the risks could be averted and of possible control points.

Box 5.3 **Cattle transport tips**

- Book the carrier early, providing details of loading time.
- Ensure the carrier's truck is appropriate for the job.
- Draft or mix cattle three weeks before transporting.
- Weigh and tag cattle 5-7 days before transporting in order to minimize bruising. Weigh 2-3 hours off feed.
- Yard cattle so that there is adequate time before trucking to allow time for any last-minute drafting, and also give the cattle the chance to settle down, cool down and rest.
- Load horned cattle so that they are in separate pens from polled cattle.
- Load cattle of similar weights together.
- Avoid loading cattle from different paddocks together.
- Check that all cattle identification devices are in place.
- Complete all paperwork to accompany the cattle.
- Provide the driver with any drafting details and any cattle delivery instructions that need to be passed on to the abattoir.

Source: adapted from Blackwood, 2001.

TABLE 5.2 **Identification and traceability during transport**

Risks/hazards and control points	Recommended practices	Suggested measures to achieve recommended practice
Risks • Stress. • Injury of animals. • Contamination of animal skins with faeces and urine. • Transmission of disease pathogens. **Control points** • Selection of cattle that are to be transported. • Handling during mustering, loading and offloading. • Design of handling facilities. • Design and working condition of transport vehicles. • Driver's skills. • Trip scheduling. • Training and supervision of animal handlers. • Good livestock identification and record-keeping system.	• Cattle destined for slaughter should be transported to the abattoir with minimum stress, low risk of injury and of contamination. • Livestock identity should be maintained throughout in order to facilitate recall and trace-back.	• Transport vehicles should be designed so that animals can be loaded, transported and offloaded easily with minimum risk of injury. • Transportation vehicles should be adequately ventilated and should be designed so that cleaning and sanitation can be readily achieved. • Only healthy animals that are fit for travel should be loaded on transport vehicles. • Animals of different species or of the same species that are likely to cause injury to one another should be physically separated during transportation. • Use of floor gratings, crates or similar devices limits soiling and cross-contamination with faecal material. • Where the vehicle has more than one deck, animals should be protected from cross-contamination as appropriate. • Ensure that animal identification is maintained and that records of dispatched animals are accurate.

Summary

- Transportation involves assembly, loading, confinement with and without motion, rest periods, unloading, penning and a new and unfamiliar environment – a series of situations that are stressful to livestock.
- Animals should be handled in such a way that they are subjected to minimum stress prior to transportation and are fit to travel with minimum risk of injuries. A rest period after mustering and handling before transportation is essential.
- Yards should be constructed to avoid sudden changes in level, steep slopes, dim and uneven lighting, narrow passages and sharp turns.
- Competent stock handlers who have a basic knowledge of animal behavioural and physical needs should supervise loading of livestock on to transport vehicles.
- Loading should take place from a properly constructed ramp or loading bay suitable for cattle, or an appropriate portable facility where a permanent loading ramp is not available.
- The loading pathway should have no protrusions or sharp edges on the fences or gateways or objects that could impede the movement of animals in any way.
- Use of electrical prods should be minimal. Animals should be encouraged to move in response to sound rather than physical coercion.
- Vehicles or rail wagons should be clean, dry and appropriately constructed to prevent cross-soiling and injury to animals.
- The following classes of livestock should be segregated and transported in separate groups:
  - horned cattle;
  - hornless cattle;
  - adult bulls;
  - cattle greatly different in size (cows and calves may preferably be transported together under some circumstances);
  - weak cattle, which should be segregated from strong cattle.

  Cattle should not be mixed with other species during transport.
- Loading density and penning arrangements should be compatible with the welfare of cattle and the capacity of the transport vehicle. Loading rates must be assessed for each pen or division in the stock crate, taking into account the characteristics of the animals to be loaded (i.e. size, condition, presence of horns), the traffic density and the presence of hills on the route to be used.
- The major factors determining the well-being of cattle in road transport are vehicle design, stocking density, ventilation, the standard of driving and the quality of the roads. Resting periods with access to water are necessary when journeys exceed 24 hours.
- All cattle must be offered water as soon as possible after arrival at the destination.
- The drover or transport driver should bring to the attention of the person in charge at the destination any aspect of the journey that might affect the future welfare of the animals. A system should be in place for delivery of cattle to abattoir premises outside business hours.
- There should be facilities for the humane offloading or slaughter of animals that are unable to walk off because of injury or exhaustion. Severely injured animals must be humanely killed without delay.
- Vehicles should be serviced and maintained regularly to minimize breakdowns. The crates should be maintained in good working order.

- The roles of the people involved at each stage of livestock transportation should be clearly defined.
- Animal identification should be maintained throughout transportation and all records and required documents should be appropriately completed and transmitted.
- Premises that slaughter animals should have suitable facilities where animals can be held on arrival.

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SECTION 6

Ante-mortem inspection

Ante-mortem inspection

Ante-mortem inspection systems required by the competent authority should include the following:

- all relevant information from the level of primary production should be taken into account on an ongoing basis, e.g. declarations from the primary producers relating to the use of veterinary drugs, information from official hazard control programmes;
- animals suspected as being unsafe or unsuitable for human consumption should be identified as such and handled separately from normal animals;
- results of ante-mortem inspection should be made available to the competent person undertaking post-mortem inspection before animals are examined at the post-mortem stations so as to augment final judgement. This is particularly important when a competent person undertaking ante-mortem inspection judges that a suspect animal can proceed to slaughter under special hygiene conditions;
- in more equivocal situations, the competent person undertaking ante-mortem inspection may hold the animal (or lot) in special facilities for more detailed inspection, diagnostic tests and/or treatment;
- animals condemned as unsafe or unsuitable for human consumption should be immediately identified as such and handled in a manner that does not result in cross-contamination of other animals with food-borne hazards; and
- the reason for condemnation should be recorded, with confirmatory laboratory tests being carried out if deemed necessary. Feedback of this information to the primary producer should take place.

MEATCOPHOTOS

Ante-mortem judgement categories include:

- passed for slaughter;
- passed for slaughter subject to a second ante-mortem inspection after an additional holding period, e.g. when animals are insufficiently rested, or are temporarily affected by a physiological or metabolic condition;
- passed for slaughter under special conditions, i.e. deferred slaughter as " suspects" , where the competent person undertaking ante-mortem inspection suspects that post-mortem inspection findings could result in partial or total condemnation;
- condemned for public health reasons, i.e. due to meat-borne hazards, occupational health hazards or likelihood of unacceptable contamination of the slaughter and dressing environment following slaughter;
- condemned for meat suitability reasons;
- emergency slaughter, when an animal eligible for being passed under special conditions could deteriorate if there were a delay in slaughter; and
- condemned for animal health reasons, as specified in relevant national legislation, and disposed of accordingly.

Source: FAO/WHO, 2004.

Diseases covered in this section

GENERAL PATHOLOGICAL CONDITIONS

SPECIFIC DISEASES

DISEASES CAUSED BY VIRUSES

DISEASE CAUSED BY PRIONS

DISEASES CAUSED BY *RICKETTSIA* AND *MYCOPLASMA* SPP.

DISEASES CAUSED BY BACTERIA

INTRODUCTION

Inspection of the live animal prior to slaughter is an important step in the production of wholesome meat for human consumption. Only in the live animal can abnormalities of posture, movement and behaviour be detected. Ante-mortem inspection can improve the efficiency of the operation by screening out a number of animals that would be unfit for consumption. This section outlines the process of ante-mortem inspection and indicates the actions that can be taken to protect human and animal health.

Meat inspection is commonly perceived as the sanitary control of slaughter animals and meat. The aim of meat inspection is to provide safe and wholesome meat for human consumption. Meat inspection covers both ante- and post-mortem inspection.

The responsibility lies primarily with the relevant public health authorities who are represented by veterinarians and meat inspectors at the abattoir stage.

In many developing regions and in particular in rural abattoirs, meat inspectors often lack the necessary information and guidelines to assess the sanitary status of carcasses, meat and organs from slaughter animals. Therefore this section and Section 8 on post-mortem inspection provide concise guidelines on the subject, together with colour illustrations demonstrating the pathological lesions that may occur in bovines, small ruminants, pigs, game, poultry and rabbits. The statements made on the judgement of diseased carcasses or parts of the carcasses are recommendations that are also influenced by the need to salvage as much meat as possible for human consumption. These recommendations are not meant to interfere with any existing regulations on the subject in individual countries.

AIMS OF ANTE-MORTEM INSPECTION

The primary aim in all inspections throughout the meat-processing operation is the protection of the consumer from zoonotic or meat-borne disease. Ante-mortem inspection also increases the protection of slaughter personnel from disease, these people being the first in the chain to have direct contact with the animal and its products.

A further aim is to protect animal health. The slaughterhouse receives animals from many origins, and is an ideal place to monitor the health of the livestock in the local area. Animal diseases that have severe consequences for national animal health, trade and the economy are often notifiable, and the ante-mortem inspection at the slaughterhouse can be a significant early-detection point for such diseases. The third aim of ante-mortem inspection is to monitor and improve animal welfare, by the detection of existing or potential problems, and the implementation of appropriate control measures.

THE PROCESS OF ANTE-MORTEM INSPECTION

Ante-mortem inspection should ideally be carried out at the time of the animals' arrival at the slaughterhouse. There needs to be sufficient natural or artificial light to allow observation of the animals in motion and also at rest. At the time of arrival, the condition of the transport vehicle can also be assessed, and if an animal has suffered injury during transport, action can be taken to prevent further suffering.

If it is not possible to carry out inspection at the time of the animals' arrival, an inspection should be carried out within 24 hours after arrival, again to prevent further suffering in the event of a welfare problem.

The ante-mortem inspection should also be carried out within the 24-hour period prior to slaughter, as signs of disease may become manifest as time progresses. Where animals remain in the lairage for longer periods of time, they may be inspected more than once.

In the ideal situation, the ante-mortem inspection will be accompanied by examination of information relating to the animal's life and health history (Photos 6.1 and 6.2). This chain information can give useful indications of the overall health status of the herd or flock of origin, the possibility of there being chronic lesions in the carcass produced, and a guarantee that there will be no chemical residues in the meat as a result of medications administered or pesticides used.

M. BLEICH, SWITZERLAND

PHOTO 6.1
A veterinary inspector examines information relating to the animal's life and health history

Ante-mortem inspection has two components:

- the screening of animals and segregation of animals suspected of being diseased or in an unsatisfactory condition;
- veterinary examination and diagnosis of the screened-out animals.

In general, any animal that deviates from normal should be segregated during the initial screening process. There are some exceptions of minor significance, such as cows with one horn or with an extra teat, minor cuts, etc.

Some suggested abnormalities to look out for in the initial screening process are listed below.

Abnormalities in breathing

Usually this refers to frequency of respiration, but there are also other abnormalities, such as frequent coughing and difficulty in breathing. The main point to remember is that if the breathing pattern differs from normal, the animal should be screened out.

Abnormalities in behaviour

Abnormalities in behaviour can be significant in some very serious diseases, such as rabies, bovine spongiform encephalopathy (BSE) and lead poisoning.

Examples of abnormal behaviour are:

- an animal pushing its head against the wall;
- an animal walking in circles;
- an animal charging at various objects;
- an animal with an anxious expression in its eyes;
- an animal with a dull expression in its eyes;
- an animal that is acting very aggressively.

Animals that behave in an abnormal way should be screened out at the time of ante-mortem inspection. Special attention should be given to ensuring that the animal will not pose a danger to other animals or to humans.

Abnormalities in gait

When an animal has an abnormal gait or is reluctant to move, it usually indicates that there is pain somewhere. The animal may be suffering from abnormalities anywhere in its legs or may have pain in the chest or abdomen. This may also indicate nervous disorders.

Abnormalities in posture

An animal with abnormal posture:

- may stand with the abdomen tucked in;
- may lie with its head turned and along its side;
- may stand with its feet stretched out in front;
- may stand with its head and neck extended;
- may be unable to rise.

Normal animals may sometimes temporarily assume postures that may be mistaken for abnormal postures, e.g. a cow that has rested for a long time may stretch and stand with its legs out in front as in some disease conditions; also, resting cattle sometimes have their heads turned along their sides. In normal animals this posture disappears when the animal is stimulated.

The most frequently observed abnormal posture is of course the downer . Downers are any animals that cannot stand or can only stand for short periods. Such animals must be handled without causing undue suffering and are usually segregated on initial ante-mortem inspection. If they cannot be segregated, operations should cease so that they may be dealt with. After veterinary inspection, downers must be stunned in the yard if moving them causes undue pain, and sent directly to the appropriate bleeding area.

Abnormal discharges or protrusions from body openings

The normal animal has no discharges or protrusions from its body openings. Examples of abnormal discharges or protrusions from the body are:

- discharge from the nose;
- bloody diarrhoea;
- excessive saliva coming out of the mouth;
- afterbirth hanging out of the vulva;
- calf leg protruding from the vulva;

PHOTO 6.2
A veterinary inspector examines information relating to the animal's identification

M. BLEICH, SWITZERLAND

- intestine protruding from the rectum;
- uterus protruding from the vulva;
- growth protruding from the eye.

Abnormal colour

Abnormal colour is generally not as important as the other abnormalities, but the inspector should be on the lookout for this. Examples are:

- black areas on the skins of pigs;
- red areas in light-coloured skin (inflammation);
- dark blue areas, e.g. gangrenous udder;
- yellow coloration of the sclera of the eye or skin (jaundice).

Abnormalities in appearance (conformation)

Inspectors will see many of these. Whenever there is a change in the normal conformation of an animal, a disease process should be suspected. Examples are:

- swelling of the skin (abscesses);
- enlarged joints;
- swelling of the umbilicus;
- greatly enlarged udder;
- bloated abdomen;
- swollen legs;
- enlarged jaws (lumpy jaw);
- pendulous lower abdomen (hanging down);
- swelling of subcutaneous lymph nodes.

In some instances it is helpful to compare both sides of the animal to find discrepancies. Any animal affected with the above abnormalities or other abnormalities of conformation should be segregated for veterinary inspection.

Abnormal odour

This is often difficult to detect on ante-mortem inspection. Examples of odours found at ante-mortem are stinkweed, medicinal or punctured abscess odours. The inspector should hold the animals for veterinary inspection whenever there is suspicion that an animal is affected with an abnormal odour.

The initial inspection will allow normal animals to proceed to slaughter while those showing any abnormality should be separated into an isolation facility and kept for further inspection and, if necessary, a full examination by an appropriate competent person.

OUTCOMES OF ANTE-MORTEM INSPECTION

For the isolated animals, a detailed inspection follows the initial separation. The animals could be judged into any one of the following categories that have been proposed in the *Draft code of hygienic practice for meat* (FAO/WHO, 2004):

- **Passed for slaughter.** These are animals that have been judged normal and so can proceed to slaughter without undue delay.
- **Passed for slaughter subject to a second ante-mortem inspection.** A second ante-mortem inspection should be carried out after an additional holding period. Animals that would fall in this category include those that have been insufficiently rested, or are temporarily affected by a physiological or metabolic condition.
- **Passed for slaughter under special conditions.** Where the competent person undertaking ante-mortem inspection suspects that post-mortem inspection findings could result in partial or total condemnation, the animals are treated as suspects . Their slaughter is deferred, preferably to the end of normal slaughter.
- **Condemned.** Animals could be condemned for:
  - public health reasons due to the presence of meat-borne hazards, occupational health hazards or the likelihood of

unacceptable contamination of the slaughter and dressing environment following slaughter;
  - meat suitability reasons;
  - animal health reasons – animals in this category are treated as specified in relevant national legislation, and disposed of accordingly.
- **Emergency slaughter.** This judgement is made when an animal eligible for being passed under special conditions could deteriorate if there were a delay in slaughter.

ANIMALS THAT DO NOT FALL INTO THE "NORMAL" CATEGORY

An animal condemned for signs of serious animal disease should be removed from the slaughter process immediately. In the event of this disease being a notifiable disease, it must be reported immediately to the competent authority, and the carcass destroyed and disposed of in accordance with legislative requirements. If the animal has a disease that can be transmitted to other animals, other animals must be protected through hygiene and biosecurity measures.

An animal showing signs of zoonotic disease, or other disorders that would make the meat unfit for human consumption, must be removed from the slaughter process. This animal could be slaughtered in a separate facility, or at the end of the processing line, after which its products should be disposed of hygienically, and the slaughter facility thoroughly cleaned and disinfected to prevent contamination being carried over to the next processing batch.

Behavioural or postural abnormalities may be seen when animals are fatigued, injured or suffering from neurological disease. Animals that are fatigued or stressed may be rested for 24 hours or more prior to slaughter, although severe cases may need to be slaughtered on welfare grounds. Animals that are to be rested require adequate space and bedding, water, food and tranquillity.

Animals showing signs of neurological disease must be separated from the normal animals and examined carefully, as these diseases may be of great public health or animal health significance. Ruminants may carry transmissible spongiform encephalopathies (TSEs), while listeriosis can manifest as neurological disease in animals (Box 6.1).

When animals are injured, it is important to ensure that they do not undergo unnecessary suffering. Other animals should be removed from the immediate area, and the injured animal slaughtered without delay. Processing of the resultant carcass should be carried out in a separate area, as there may be hygiene implications relating to the specific nature of the injury, and the animal is often dirty if it was recumbent.

Animals that are dirty can pose a severe risk to meat hygiene. Many of the causes of food-borne disease in humans are carried in the intestinal content and on the skins of animals. When the animal is visually dirty, there is an increased likelihood of these organisms being transferred to the meat during processing of the carcass. Dirty animals should be identified at ante-mortem inspection and removed from the slaughter process (Box 6.2). These animals could be cleaned prior to being re-presented for ante-mortem inspection. Cleaning could involve shaving or clipping the hair coat, or washing the animal. When an animal is washed, it is important that the coat is then allowed to dry before processing begins; otherwise contaminated fluid will be expressed onto the meat during skinning in the manner of a cloth being squeezed. It may be possible in some slaughter facilities to process the animals at the end of the line, using careful dressing procedures to limit the risk of contamination. For example, dirty hair may be clipped off and removed after slaughter and bleeding, but before skinning begins.

Animals found dead should be recorded and sent for rendering. Condemned animals or their carcasses, and animals found dead, should never be permitted to pass through the slaughter floor or other areas of the establishment that are used for handling edible parts of the carcass.

Box 6.1 **Neurological disease - a disease of the nervous system or brain**

TRANSMISSIBLE SPONGIFORM ENCEPHALOPATHY (TSE)

- For example, bovine spongiform encephalopathy (BSE) in cattle, scrapie in sheep.
- Linked to variant Creutzfeldt-Jakob Disease (vCJD), a fatal degeneration of the brain in humans.
- Animals with clinical signs should not be used for human or animal feed production.
- There may be a requirement to remove certain tissues of ruminants from the food chain.
- Some animals may be tested prior to their carcass entering the food chain.

LISTERIOSIS

- Bacterial meningitis, classically presenting as circling behaviour.
- Zoonotic disease.
- Infected animals are unfit for consumption.

Box 6.2 **Livestock cleanliness categories of the Irish Department of Agriculture and Food**

In 1998 the Irish Department of Agriculture and Food introduced regulations to address the issue of excessively dirty cattle at the abattoir. These regulations allow the ante-mortem veterinary inspector to reject animals for slaughter or to permit slaughter under special conditions.

On the basis of pictorial and written guidelines, cattle are placed in categories from 1 (very clean) to 5 (very dirty). Normal dressing procedures are employed for categories 1 and 2, with extra care being taken for animals with wet hides. Slowing of the line speed, reduced numbers of carcasses on the line and improved workstation hygiene are considered for category 3 animals. Category 4 animals are slaughtered under similar special conditions at the end of the day and category 5 animals are rejected for slaughter.

Cleanliness categories:

CATEGORY 1
No evidence of adherent faecal material and very limited amounts of loose straw/bedding.

CATEGORY 2
A light covering of dried faecal material and limited amounts of loosely adherent straw/bedding.

CATEGORY 3
Animals with significant amounts of straw/bedding/dirt over large areas of predilection sites.

CATEGORY 4
Animals with heavy amounts of adherent dirt/faeces on fore and hind legs and/or on predilection sites and/or significant amounts of straw/bedding attached to the hide or between areas of dried faecal material. Hide clipping may be practised before animals are permitted for slaughter.

CATEGORY 5
Animals with very heavy amounts of adherent dirt/faeces on predilection sites. Balling of adherent dirt/faeces may be evident on the underside of the abdomen. Animals are rejected for slaughter and returned to the premises of origin or subjected to hide clipping.

Source: Doherty, 1999.

GENERAL PATHOLOGICAL CONDITIONS

Fever (pyrexia)

Fever is an abnormal elevated body temperature. It may be classified as septic or aseptic according to the presence or non-presence of an infection. In septic fever the infection is caused by viruses, bacteria, bacterial toxins, protozoa or fungi. Aseptic fever may be caused by:

- tissue necrosis, as seen in muscle degradation due to intermuscular injection of necrotizing substances, in rapidly growing tumours undergoing necrosis or lysis of burned tissue;
- chemicals or surgery – in the former by an administration of drugs and in the latter by breakdown of tissue and blood;
- anaphylactic reaction of antibodies to foreign antigens.

Ante-mortem findings:

- chills and sweating;
- dehydration;
- elevated body temperature;
- increased pulse and respiration;
- depression and dullness;
- anorexia and constipation.

In septic fever, other signs may include:

- diarrhoea and vomiting;
- urinous or phenolic odour of breath;
- shock, convulsions and coma.

Differential diagnosis:

Hyperthermia and septicaemia. In hyperthermia the elevation of body temperature is caused by physical factors such as high environmental temperature or prolonged muscular exertion, particularly in humid weather.

Inflammation in viral diseases

Inflammation associated with viral diseases is usually secondary to primary cellular change. Secondary bacterial infections frequently accompany and complicate viral diseases, particularly respiratory and skin diseases. Viral infection associated with fever, malaise, anorexia or incoordination is attributed to absorption of injured cell products, viral toxicity and viral abnormalities that cause circulatory disturbances. Vascular shock, together with viral toxicity and failure of one or more vital organs, is thought to be associated with death in viral diseases.

Septicaemia

Septicaemia is a morbid condition caused by the presence of pathogenic bacteria and their associated toxins in the blood. The positive diagnosis of septicaemia can only be made by isolation of the causative organism from the bloodstream. This is not practised on routine ante-mortem inspection of animals in abattoirs; however, the evidence of septicaemia is determined by the ante-mortem and post-mortem findings.

Ante-mortem findings:

- depression;
- changes in body temperature – the temperature is usually elevated, but it can also be normal and subnormal during the terminal phases;
- difficult and rapid breathing;
- shivering and muscle tremors;
- congestion or petechial haemorrhages of conjunctivae, mouth and vulvar mucosae.

Toxaemia

The identification of toxaemia presents some difficulties on routine ante-mortem and post-mortem inspection. The gross lesions differ depending on the specific organisms and toxins involved. Also the clinical signs of toxaemia simulate a variety of other pathologic conditions. Toxaemia is defined as the presence and rapid proliferation of exotoxin and endotoxin derived from micro-organisms or produced by body cells in the bloodstream. Clinical signs and post-mortem findings are similar to those of septicaemia.

Ante-mortem findings:

- normal or subnormal temperature – fever may be present if toxaemia is due to micro-organisms;
- confusion and convulsions;
- abnormal changes in locomotion;
- moribund animal or evidence of pain (noted by grinding of teeth);
- animal is not able to rise or rises with great difficulty;
- dehydration may also be present.

Toxaemia is frequently associated with:

- gangrenous mastitis;
- metritis;
- aspiration pneumonia;
- old wounds and injuries;
- diffuse peritonitis due to perforation of the reticulum or uterus.

All these signs may not be seen in every animal affected with toxaemia.

Judgement:

The primary lesions causing septicaemia or toxaemia, including metritis, mastitis, pericarditis, enteritis and others, should be observed and recorded as causes of condemnation. Comatose or moribund animals should be condemned on ante-mortem inspection.

Bruises

Bruises are frequently found on ante-mortem and post-mortem inspection in food-producing animals and poultry. In cattle, bruises caused by transportation or handling are commonly found in the hip, chest and shoulder areas; in pigs, within the ham and in sheep, in the hind leg. Bruises and haemorrhage in the hip joint are caused by rough handling of animals during shackling. Bruises in poultry can be localized or generalized and are frequently associated with bone fractures or ruptured ligament tendons.

Judgement:

Bruised animals should be treated as suspects on ante-mortem inspection.

Abscesses

An abscess is a localized collection of pus separated from the surrounding tissue by a fibrous capsule.

Judgement:
The judgement of animals affected with abscesses depends on findings of primary or secondary abscesses in the animal. The portal of entry of pyogenic organisms into the system is also of importance. The primary abscess is usually situated in tissue that has contact with the digestive tract, respiratory tract, subcutaneous tissue, liver, etc. The secondary abscess is found in tissue where contact with these body systems and organs is via the bloodstream.

Inspectors should differentiate between abscesses in the active and growing state and older calcified or healed abscesses. In domestic animals, the primary sites of purulent infections are post-partum uterus, umbilicus or reticulum in hardware disease. Secondary abscesses are frequently observed in distant organs.

Animals affected with abscesses spread through the bloodstream (pyemia) are condemned on ante-mortem if the findings of abscesses are over most areas of the body and systemic involvement is evident, as shown in elevated temperature and cachexia.

Emaciation

Emaciation is a common condition of food animals and is characterized by a loss of fat and flesh following loss of appetite, starvation and cachexia. It is associated with gradual diminution in the size of organs and muscular tissue, as well as oedema in many cases. The organs and muscular tissue appear thinner, moist and glossy. Cachexia is a clinical term for a chronic debilitating condition or general physical wasting caused by chronic disease.

Emaciation may be associated with chronic diseases and parasitic conditions such as roundworms in pigs and fascioliasis in cattle and sheep, swine erysipelas, neoplasms, tuberculosis, Johne’s disease, caseous lymphadenitis, poor teeth and lack of nutrition. Emaciation is a post-mortem descriptive term that should be differentiated from thinness.

Ante-mortem findings:
- wrinkled, dry leathery skin;
- rough hair coat;
- prominent bones and sunken eyes.

Judgement:
Animals affected with emaciation should be treated as suspects on ante-mortem inspection.

Differential diagnosis:
Thinness/leanness, oedema and uraemia.

Leanness (poorness) is often observed in range bulls on poor-quality pasture, high-milking cows and young growing animals that have had a protein-deficient diet.

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PHOTO 6.3
Emaciated cow showing marked reduction of muscle mass

Oedema

Oedema is the accumulation of excess fluid in the intercellular (interstitial) tissue compartments, including body cavities.

There are two types of oedema:

- inflammatory oedema (exudate);
- non-inflammatory oedema (transudate).

Inflammatory oedema shows yellow, white or greenish, clear or cloudy fluid in the area of inflammation. Non-inflammatory oedema is an accumulation of fluid in subcutaneous tissue, submucosae, lungs and brain.

Localized oedema is noted after:

- the swelling of a cow's leg in prolonged decubitus – this swelling is caused by obstruction of the venous outflow;
- interference with the lymph circulation of an organ or area by proliferation of tumours in or around bile ducts;
- inflammation or an allergic reaction.

Systemic or generalized oedema may occur secondary to congestive heart failure or be caused by low protein levels in the blood.

The latter may be associated with:

- severe malnutrition;
- severe amyloidosis of the kidney;
- gastrointestinal parasitic infestation;
- chronic liver disease;
- damage to the vascular endothelium by toxins and infectious agents.

Anasarca is a form of oedema of the subcutaneous tissues. Ascites is an accumulation of fluid in the peritoneal cavity. Hydrothorax is an accumulation of fluid in the pleural cavity. Hydrothorax may accompany traumatic pericarditis, ascites, cirrhosis of the liver and roundworm infestation in sheep. Anasarca may be caused by toxaemic infection.

Ante-mortem findings:

- depressed and drowsy;
- swelling of the mandible, dewlap, legs, shoulder, brisket and abdomen;
- oedematous tissue is cool upon touch and is of a firm, doughy consistency.

Judgement:

Animals affected with generalized oedema may be condemned on ante-mortem inspection. In less severe non-generalized cases, animals are treated as suspects.

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PHOTO 6.4
Abdominal oedema caused by liver disease

Immaturity

Immaturity occurs mainly in calves. In many countries, the slaughter of calves younger than two weeks of age is prohibited.

Ante-mortem findings:

- presence of the umbilical cord;
- bluish and not completely retracted gums.

(In addition, greyish muscles that are flabby, tear easily and are not well developed, and dark red kidney and oedematous kidney capsule, are found at post-mortem.)

Plant poisoning

In developing countries, slaughter animals, and particularly cattle, are often trekked some hundreds of kilometres on the hoof to the abattoirs. During this journey, animals may suffer from various types of plant poisoning. In addition, cattle living in areas where pasture has poisonous plants may suffer from the effects of chronic plant poisoning. Different body systems may be affected and various lesions may be seen at meat inspection.

Clinical signs and gross lesions observed in animals that have ingested certain poisonous plants are listed below:

- tulip (*Tulipa* spp.) causes diarrhoea, bloated abdomen and heart failure;
- *Lantana camara* causes photosensitization;
- *Senecio* spp. cause necrosis and cirrhosis of liver;
- *Crotalaria* spp. cause laminitis;
- *Dichapetalum cymosum* causes heart failure and sudden death.

Judgement:

Judgement of the animal will depend on the clinical signs and the extent and severity of the lesions.

Chemical poisoning

Dipping of cattle in acaricide on a regular basis is practised in many parts in order to control tick-borne diseases. Chemicals used for this purpose include arsenic, chlorinated hydrocarbons and organophosphates. Dipping may lead to clinical cases of poisoning, which may be manifested with the following clinical signs: nervous system disturbances, acute abdominal pain, diarrhoea and skin lesions.

Judgement:

The carcass, offal and intestine should be condemned if clinical signs of poisoning are associated with post-mortem lesions.

SPECIFIC DISEASES

DISEASES CAUSED BY VIRUSES

Foot-and-mouth disease (FMD)

FMD is an acute viral and extremely contagious disease of cloven-footed animals such as cattle, sheep, goats, pigs and antelopes. It is manifested by vesicles and erosions in the muzzle, nares, mouth, feet, teats, udder and pillar of the rumen. There are three main strains of viruses causing FMD, namely A, O and C. Three additional strains, SAT 1, SAT 2 and SAT 3 have been isolated from Africa and a further strain ASIA-1 from Southeast Asia.

Transmission:

Direct and indirect contact with infected animals and their secretions, including saliva, blood, urine, faeces, milk and semen, aerosol droplet dispersion, infected animal by-products, swill containing scraps of meat or other animal tissue and fomites.

PHOTO 6.5
Excessive salivation in a cow affected with FMD

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Ante-mortem findings:

Before vesicle formation:

- incubation: one to five days or longer;
- morbidity: nearly 100 percent;
- mortality: variable depending on the strain of virus and its virulence and susceptibility of host; 50 percent in young animals, 5 percent in adults;
- fever up to 42 C;
- dullness;
- lack of appetite;
- drastic drop in milk production;
- uneasiness and muscle tremors.

Vesicle formation:

- smacking and quivering of lips;
- extensive salivation and drooling;
- shaking of feet and lameness.

The vesicles and later erosions are commonly found on the muzzle, tongue, oral cavity and teat, and on the skin between and above the hooves of the feet. In more chronic cases in cattle the hoof becomes loose and the animal may walk with a characteristic clicking sound (slippering).

Some strains of FMD, particularly in swine, sheep and goats, cause erosions instead of vesicles.

Judgement:

In countries or in zones within a country free or nearly free of FMD, diseased or suspect animals are prohibited from admission to an abattoir or slaughtered. In countries where this disease is present, the judgement should be in accordance with the current animal health requirements, and consistent with effective public health protection. Particular attention should be paid to secondary bacterial infections and general findings. Sanitary measures should be taken to comply with national animal health policy.

Remarks:

Latent infections with *Salmonella* organisms have been reported in animals affected with FMD.

Differential diagnosis in bovine and ovine species:

Vesicular stomatitis, allergic stomatitis, feedlot glossitis, photosensitization, bluetongue, rinderpest, infectious bovine rhinotracheitis, malignant catarrhal fever, bovine papular stomatitis, bovine viral diarrhoea, pseudocowpox, ovine pox, contagious ecthyma, foot-rot, mycotoxicosis and increased salt content in feed.

Discussion:

In order to prevent the spread of the virus in the abattoir, the equipment and room should be disinfected with 2% NaOH (caustic soda). In some countries sodium carbonate (Na_2CO_3) is used. The vehicle conveying diseased animals should also be disinfected and abattoir personnel leaving the abattoir should pass through a footbath with 1% solution of NaOH.

The virus of FMD can survive in meat and meat products for a considerable length of time. Outside the pH range of 6–9, viral infectivity is destroyed. A bovine carcass matured at above +2 C produces a drop in the pH of muscle tissue to between 5.3 and 5.7 within 24 hours of slaughter. This is caused by the formation of sarcolactic acid. Quick freezing of the meat arrests acid production and consequently the virus remains infective for about six months. In salted meat at 4 C, the virus is still infective in bone marrow and lymph nodes for six months. In blood clots in large vessels of cattle and swine, the virus is infective for two months. The virus is inactivated by ultraviolet rays, acetic acid, 2% lye and ethylene oxide. At high temperatures, the virus is only active for a short period. A solution 2% NaOH of inactivates the virus in one to two minutes. In dry refuse in stalls, the virus remains infective for 14 days, for three days on soil surfaces in summer, compared to 39 days in fall. It is also infective for 39 days in urine and for 20 weeks on hay dried at 22 C. The virus can be destroyed with 0.5% citric or lactic acid, by cooking meat to an internal temperature of 69 C and by pasteurization processes of milk.

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PHOTO 6.6

FMD: extensive areas of eroded epithelium on a bovine tongue

Rinderpest (RP)

RP is an acute, highly contagious, fatal viral disease of **cattle, buffalo** and **wild ruminants** manifested by inflammation, haemorrhage, erosions of the digestive tract, wasting and often bloody diarrhoea. Some swine species are also susceptible. Humans are not susceptible to RP virus.

Transmission:
Direct contact with infected animals or their excretions and secretions and fomites. The virus appears in the blood and in secretions before the onset of clinical signs and this may cause infection in abattoirs and stockyards.

Ante-mortem findings:
- incubation: 3–10 days or longer;
- morbidity: up to 100 percent in a susceptible herd;
- mortality: 50 percent and may reach 90–95 percent;
- high fever (41–42 C);
- nasal discharge and excessive salivation;
- punched-out erosions in the mouth;
- loss of appetite and depression;
- abdominal pain (grunting, arched back);
- constipation followed by bloody diarrhoea and straining;
- dehydration and rough hair coat;
- marked debility;
- abortion;
- the classical milk fever position in cattle.

Judgement:
In areas free of RP and in zones where the final stages of eradication exist, the animals are condemned.

Remarks:
RP virus is sensitive to environmental changes and is destroyed by heat, drying and a wide range of disinfectants.

Differential diagnosis:
Bovine viral diarrhoea, malignant catarrhal fever, infectious bovine rhinotracheitis, bluetongue, coccidiosis, FMD, vesicular and necrotic stomatitis and bovine papular stomatitis. Vesicular diseases do not have accompanying haemorrhage, and blisters should be differentiated from erosions (ulcers) seen in RP.

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PHOTO 6.7
RP erosions on the dental pad and the hard palate that resemble FMD

Vesicular stomatitis (VS)

This is a viral disease of ruminants, horses and swine characterized by vesicular lesions of the mouth, feet and teats. VS virus has two immunologically distinct serotypes: Indiana and New Jersey.

Transmission:
In susceptible animals, contamination of pre-existing abrasions with saliva or lesion material, by ingestion of contaminated pasture or during milking within dairy herds. Mechanical transmission by biting arthropods is also a possibility. The virus is isolated from mites, tropical sandflies and mosquitoes.

Ante-mortem findings:
- fever;
- mouth lesions in cattle and horses;
- vesicles tend to disappear quickly and only papules may be seen in cattle outbreaks;
- marked weight loss and cessation of lactation in dairy cows;
- chewing movements and profuse salivation;
- refuses food but eagerly acceptes water;
- horses rub lips on edges of mangers;
- foot lesions occur in about 50 percent of cases in cattle;
- lameness;
- teat lesion may occur in all species.

Differential diagnosis:
FMD, swine vesicular exanthema, vesicular disease, bovine papular stomatitis.

Mouth and muzzle lesions: bovine viral diarrhoea, rinderpest, mycotic stomatitis, photosensitization and Potomac Valley fever in horses

Teat lesions: cowpox, pseudo-cowpox, pseudo-lumpy skin disease and bovine herpes mammillitis.

PHOTO 6.8
VS: tongue lesions

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Malignant catarrhal fever (MCF)

An acute viral disease of cattle, deer, bison and buffalo characterized by inflammation of the mucous membranes of the nose and eyes, corneal opacity, profuse nasal discharge and enlargement of lymph nodes. MCF is arbitrarily divided into peracute, intestinal, head-eye and mild forms according to ante-mortem findings. It is not communicable to humans.

Transmission:
Close contact between cattle and wildebeest (gnu, antelope), by common use of drinking troughs or by direct contact between cattle and newborn wildebeest and placenta of parturient dams. In American or European cases of MCF, cattle are infected from sheep.

Ante-mortem findings:
- incubation: 9–44 days;
- morbidity is low and mortality is high;
- increased temperature;
- bilateral ocular and nasal discharges;
- dyspnoea and cyanosis;
- loss of appetite;
- encrustation of muzzle and eczema of the perineum, scrotum and udder;
- erosions on the lips, tongue, gums, soft and hard palate;
- swollen reddened eyelids, corneal opacity and conjunctivitis (Photo 6.9);
- photophobia associated with corneal opacity and blindness;
- reluctance to swallow because of oesophageal erosions and drooling;
- enlarged body lymph nodes;
- rarely, uncoordinated movements and shivering.

Differential diagnosis:
Bluetongue, RP, bovine viral diarrhoea/mucosal disease, FMD, VS.

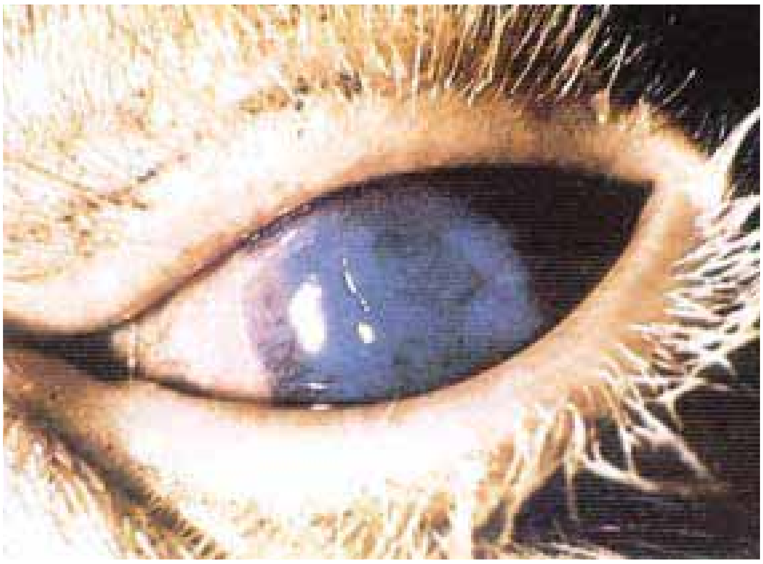

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PHOTO 6.9
MCF: early stages of corneal opacity, conjunctivitis and reddening of the eyelids

Rabies

This is an acute infectious viral disease of the central nervous system in mammals.

Transmission:
It is usually transmitted through the saliva by a bite from a rabid animal, commonly the dog or jackal. Humans are infected in the same way.

Ante-mortem findings:
Furious form:

- incubation: from two weeks to six months or longer;
- restlessness;
- aggressive, may attack other animals;
- sexual excitement;
- bellowing;
- paralysis and death;
- paralytic form;
- sagging and swaying of the hindquarters;
- drooling and salivation;
- the tail is held to one side;
- tenesmus or paralysis of the anus;
- paralysis;
- the animal falls to the ground;
- death after 48 hours of decubitus.

Differential diagnosis:
Indigestion, milk fever or acetonaemia when first seen, foreign body in the mouth, early infectious disease, poisoning.

Discussion:
In a diseased animal, the virus is found in saliva, salivary gland and nervous tissue. Extreme caution should be instituted in abattoirs in order to prevent occupational hazards. Abattoir personnel can contract the disease through surface contact with infected tissue. Infection does not occur by consumption of meat from a rabid animal.

Slaughter may be prohibited during a quarantine period of eight months following exposure to the disease. An animal suspected of having rabies should be placed under a Held tag . The warning sign should read The animal is not to be handled . Any person who was in touch with the animal should thoroughly wash his/her hands with strong soap and/or disinfectant. If possible, the wound should be opened to encourage bleeding in order to flush out the virus and expose the deeper area of the wound. Tincture of iodine (up to 0.001% aqueous solution of iodine or ethanol 43.70%) should be applied.

Lumpy skin disease

Acute pox viral disease of cattle manifested by sudden appearance of nodules on the skin.

Transmission:
Insect vectors by direct and indirect transmission. Seasonal and geographic distribution.

Ante-mortem findings:

- incubation: 4–14 days;
- fluctuating fever;
- diarrhoea;
- nasal discharge and salivation;
- the first lesions appear in the perineum;

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PHOTO 6.10
Lumpy skin disease: cutaneous nodules of various sizes in a severe case of lumpy skin disease

- cutaneous nodules of various sizes may occur throughout the body;
- skin lesions may show scab formation;
- swelling of superficial lymph nodes and limbs, and lameness;
- infertility and abortion;
- secondary infection may lead to joint and tendon inflammation.

Judgement:
The carcass of an animal showing, on ante-mortem inspection, generalized acute infection accompanied with fever, is condemned.

Differential diagnosis:
Allergies, screwworm myiasis, urticaria, dermatophilosis (streptothricosis), bovine herpes dermophatic infection, cattle grubs, vesicular disease, bovine ephemeral fever, photosensitization, besnoitiosis (elephant skin disease), sweating weakness of calves, bovine farcy and skin form of sporadic bovine lymphomatosis.

Bovine herpes dermophatic disease (BHD)

A herpes virus infection of cattle and sometimes sheep and goats manifested by cutaneous lesions and fever.

Transmission:
Biting insects, mechanical milking.

Ante-mortem findings:
- incubation: 3–7 days;
- morbidity: high in primary infections;
- fever;
- cutaneous nodules: at first these are round, then later become flattened and covered with dry scabs;
- hairless skin is normal after the scab falls off;
- ulcerative lesions of the teats and udder;
- erosions between the digits.

Judgement:
The carcass of an animal affected with BHD is condemned.

Differential diagnosis:
Dermatophilis infection, cowpox and pseudocowpox, VS and lumpy skin disease. The latter is differentiated from BHD by enlarged lymph nodes.

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PHOTO 6.11
BHD: dried scabs on the skin of the neck

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PHOTO 6.12
BHD: ulcerative lesions of the teats and udder

Infectious bovine rhinotracheitis (IBR)

IBR is a highly infectious viral respiratory disease of cattle, goats and pigs manifested by inflammation of respiratory passages and pustular lesions on the male and female genital organs. Generally four forms of the disease are recognized; the respiratory form, the genital form, the enteric form and the encephalitic form.

Transmission:
Respiratory droplet and nasal exudate in the respiratory form of IBR. Obstetrical operations, coitus and licking of genitalia of affected animals in the genital form of disease.

Ante-mortem findings:
Respiratory form:

- incubation: 5–14 days;
- fever;
- nasal and ocular discharge and red, swollen conjunctiva;
- drop in milk yield;
- breathing through the mouth and salivation;
- hyperaemia of the nasal mucosa and necrotic areas on the nasal septum;
- secondary bronchopneumonia;
- abortion.

Genital form:

- frequent urination and tail elevation;
- oedematous swelling of the vulva and pustule formation on reddened vaginal mucosa;
- mucoid or mucopurulent exudate in the vagina.

Enteric form:

- severe oral and stomach necrosis in newborn animals;
- high mortality.

The encephalitic form in calves:

- depression;
- excitement;
- high mortality.

Judgement:
The carcass of an animal affected with IBR is approved if signs of acute infection are not present and the animal is in good body condition.

Differential diagnosis:
Pneumonic pasteurellosis, bovine viral diarrhoea, MCF and calf diphtheria.

PHOTO 6.13
Breathing through the mouth and salivation in a bovine affected with IBR

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Bovine viral diarrhoea (BVD)

This is an infectious viral disease of cattle manifested by an active erosive stomatitis, gastroenteritis and diarrhoea.

Transmission:
Direct contact with clinically sick or carrier animals, indirect contact with feedstuffs or fomites contaminated with urine, nasal and oral secretions or faeces, and contact with aborted foetuses. Transmission through aerosol droplet dispersion or by insect vector may also be a possibility. Virus may persist in recovered and chronically ill cattle, which are considered a potential source of infection.

Ante-mortem findings:
- incubation: 1–3 days;
- fever;
- congestion and erosions in the mucous membranes of the oral cavity;
- depression and anorexia;
- cough, polypnea and salivation;
- dehydration and debilitation;
- foul-smelling diarrhoea;
- cessation of rumination;
- reduced milk supply;
- abortion in pregnant cows;
- laminitis;
- congenital anomalies of the brain (cerebellar ataxia) and arthritis in young calves.

Judgement:
The carcass and viscera of an animal that on ante-mortem inspection shows generalized signs of acute infection accompanied with fever and/or emaciation, are condemned. Chronic cases of BVD with no systemic involvement have a favourable judgement of carcass, viscera and organs.

Differential diagnosis:
MCF, RP, bluetongue and vesicular diseases. The latter produce vesicles that are not present in BVD. Diseases with no oral lesion or diarrhoea include salmonellosis, Johne’s disease and parasitism.

Bovine leukosis

Bovine leukosis is a persistent and malignant viral disease of the lymphoreticular system. It occurs in all breeds and in both sexes.

Bovine leukosis is observed in two forms: a) the sporadic and b) the enzootic form. The sporadic form is rare and occurs in cattle under three years of age. The enzootic form is most commonly found in adult cattle, particularly in cull cows.

Transmission:
By small amounts of infected blood (e.g. infected needles, dehorning), vertical transmission from the dam to the calf (3–20 percent of calves may become infected) and by colostrum or milk (less than 2 percent). Insect transmission is also a possibility; higher rates of infection are reported in the summer.

Ante-mortem findings:
- laboured breathing due to heart involvement;
- persistent diarrhoea following infiltration of the abomasum wall by neoplastic cells;
- marked enlargement of several superficial lymph nodes;
- oedema of the brisket and the intermandibular region;
- paralysis of the hind legs due to tumour compression of the spinal cord;
- protrusion of the eye as a result of tumour invasion of the orbital cavity;
- debilitation or emaciation;
- pale mucosal surface;
- bloated animal;
- swelling of the neck when thymus is involved;
- cutaneous nodules in the terminal stage.

Differential diagnosis:
Lymphadenitis, lymphoid hyperplasia, hyperplastic haemolymph nodes, pericarditis, enlarged spleen in septicaemic conditions, other neoplasms and parasitism.

DISEASE CAUSED BY PRIONS

Bovine spongiform encephalopathy (BSE, “mad cow disease”)

BSE is a progressive and fatal disease of adult cattle characterized by degeneration of the central nervous system (CNS). The causative agent is thought to be composed of an abnormal form of the host-encoded prion protein (PrPc), termed PrPsc. It is believed that the infective prion (PrPsc) induces a conformational change of the host’s natural prion (PrPc), which leads to degeneration of the CNS.

Transmission:
The main transmission pathway is the ingestion of BSE-contaminated feeds, which are in most cases protein feed supplements made from BSE-contaminated meat and bone meal.

Ante-mortem findings:
Cattle with BSE tend to have subtle signs of disease. Signs are progressive, variable in type and severity, and may include depression, abnormal behaviour, weight loss, sensitivity to stimuli (light, sound, touch), and gait or movement abnormalities. Other signs that have been noted in some BSE cases include reduced milk yield, bradycardia, and reduced ruminal contractions. None of these signs are specific (pathognomonic) for the disease.

The following clinical signs may occur:

1. Disturbances in behaviour
2. Disturbances in locomotion
3. Disturbances in sensitivity
4. Slow weight loss

No diagnostic test for the BSE agent in the live animal is presently available. Current post-mortem diagnostic methods are histopathological and detection of the infectious Prion PrPsc.

Judgement:
The carcass is condemned.

Differential diagnosis:
Listeriosis, viral encephalitis (sporadic bovine encephalitis, Borna disease), bacterial encephalitis, brain oedema, tumors, cerebrocortical necrosis, cerebellar atrophy (Purkinje cells), metabolic diseases and others.

Discussion:
BSE was first diagnosed in cattle in the United Kingdom in 1986. It is now been recognized in many other countries in and outside Europe. BSE belongs to a group of human and animal diseases classified as transmissible spongiform encephalopathies (TSE). Significant human diseases of this group are variant Creutzfeldt-Jakob disease (vCJD), Creutzfeldt-Jakob disease (CJD), Kuru and Gerstmann-Str ussler-Scheinker syndrome. Of these, only vCJD has been associated with BSE. TSE-affected animals are bovines (BSE), sheep and goats (scrapie), cervids (chronic wasting disease [CWD]), minks (transmissible mink encephalopathy [TME]) and felines (feline spongiform encephalopathy [FSE]). Cattle testing positive for BSE have ranged from 20 months to 19 years of age, though most of the cases are between 4 and 6 years of age. A breed or genetic predisposition has not been found. Most cases of BSE have come from dairy herds, probably due to differences in feeding systems compared to beef cattle.

Two levels of control and prevention measures must be considered:

1. those that block the cycle of amplification in the feed chain;
2. those that prevent infective material from entering human food.

Measures to protect animal and human health:

- Introduction of feed bans
- Utilization of appropriate rendering parameters
- Removal from the food chain of specified risk material (SRM)
- Introduction of measures to avoid cross-contamination of meat with SRM
- Ban of mechanically recovered meat for food
- Import control
- Introduction of surveillance systems (active and passive)
- On-farm measures
- Identification and elimination of clinically affected animals before slaughter.

DISEASES CAUSED BY *RICKETTSIA* AND *MYCOPLASMA* SPP.

Heartwater (hydropericardium)

Black dung when affecting African cattle and buffalo; Sheep fever when seen in sheep.

Heartwater is an acute, non-contagious disease of cattle, sheep, goats, antelopes and wild ruminants. It is caused by the rickettsial organism *Cowdria (Rickettsia) ruminantium*.

Transmission:

Heartwater is transmitted by various species of *Amblyomma* ticks. Transstadial transmission of the organism occurs in vector ticks.

Ante-mortem findings:

Peracute form:

- incubation: 14–28 days;
- fever;
- diarrhoea;
- convulsions and death.

Acute form:

- fever up to 42 C;
- rapid breathing;
- lack of appetite, depression and listlessness.

Nervous signs include:

- twitching of the eyelids;
- protrusion of the tongue;
- champing of the jaw;
- walking in circles;
- paddling with legs in recumbent animals; opisthotonos (arched back) and convulsions.

Differential diagnosis:

Peracute form of heartwater should be differentiated from anthrax. The acute nervous form of the disease is differentiated from tetanus, rabies, cerebral trypanosomiasis, strychnine poisoning, piroplasmosis, theileriosis, lead and organophosphate poisoning, parasitism, arsenical poisoning and poisoning with certain plants.

Q fever (Queensland fever, Nine mile fever, American Q fever, Australian Q fever)

Q fever is a disease of cattle, sheep, goats, donkeys, camels, fowl, dogs, cats, pigeons and humans. It is caused by *Coxiella burnetii*. Q fever is an occupational disease of livestock personnel, farmers and laboratory personnel.

Transmission:

Ticks spread infection to cattle, which develop mild disease. The faeces deposited on animal hide by ticks may be the source of infection for humans. Q fever is also transmitted by inhalation of dust contaminated with infected animal secreta or excreta. Healthy animals may serve as carriers and shed the organism in milk, urine, faeces, placenta and foetal fluids. They harbour the infection and no clinical signs are observed. Contaminated meat and water are further means of infection spread.

In field cases, there are no clinical signs of this disease. In the disease produced by the inoculation of cows via the udder the clinical signs may include:

- acute mastitis;
- loss of appetite and depression;
- serous nasal and lacrimal discharge;
- difficult breathing;
- atony of the rumen;
- abortion in pregnant cows;
- no gross lesions are reported in cattle.

Discussion:

Coxiella burnetii is highly resistant and has been isolated from farm soil six months after the removal of animals. It may persist in the udder for up to three years. The temperatures of milk pasteurization (in bulk at 63 C for 30 minutes or the common method at 72 C for 15 seconds) kill this agent in milk. Vaccination will reduce shedding of organisms in milk.

This disease in humans has a sudden onset and is characterized by loss of appetite, weakness and generalized malaise lasting from one to two weeks. Pneumonia may also be present. Death may be caused by endocarditis in older people. More severe symptoms of Q fever are noticed.

Contagious bovine pleuropneumonia (CBPP)

This is an acute, subacute or chronic highly infectious disease of cattle caused by *Mycoplasma mycoides* var. *mycoides*.

Transmission:
Aerosol and droplet infection from the infected animals. Recovered animals, called lungers , may act as carriers and shedders, especially under stress.

Ante-mortem findings:
- incubation: acute: 10–14 days, chronic: 3–6 months;
- morbidity: 90 percent in susceptible cattle;
- mortality: 10–50 percent;
- fever;
- depression;
- lack of appetite and loss of weight;
- coughing on exercise;
- shallow rapid respiration, grunting and gurgling;
- extended neck, lowered head and open mouth;
- arched back and outward rotated elbow;
- arthritis in young animals.

Judgement:
The carcass of an animal affected with CBPP is condemned if the disease is associated with fever, inadequate bleeding of carcass, serous infiltration of the brisket and emaciation. Recovered animals showing no generalized signs of the disease are approved and the affected organs are condemned.

Differential diagnosis:
Shipping fever (pasteurellosis), East Coast fever, foreign body pneumonia, IBR, tuberculosis, chlamydial infections and lungworms.

DISEASES CAUSED BY BACTERIA

Blackquarter (blackleg)

Blackquarter is an acute infectious disease of cattle and sheep manifested by severe inflammation of the muscle with high mortality. It is caused by *Clostridium chauvoei*.

Transmission:
The organisms of blackleg are found in the soil. During grazing, organisms may enter the digestive tract of a susceptible animal. *C. chauvoei* is also found in the digestive tract of healthy animals. In sheep, the agent is transmitted through wounds at shearing, docking and castration, and during lambing in ewes.

Ante-mortem findings:
- high fever (41 C);
- lameness;
- loss of appetite;
- discoloured, dry or cracked skin;
- stiff gait and reluctance to move;
- crepitating swellings often on the hips and shoulders;
- in sheep, gaseous crepitation cannot be felt before death.

Judgement:
Carcasses of animals affected with blackleg should be condemned. It is prohibited to slaughter and dress an animal diagnosed with this disease at ante-mortem inspection.

Differential diagnosis:
Other acute clostridial infections, lightning strike, anthrax, bacillary haemoglobinuria, lactation tetany, extensive haemorrhage and acute lead poisoning.

Discussion:
Blackleg is worldwide in distribution. Well nourished animals are more frequently affected. It is also more commonly seen in grass-fed animals than in stall-fed animals. Clostridia are soil-borne organisms that cause disease by releasing toxins. Specific antitoxins and antibiotics are rarely effective in the treatment of this disease. An adequate preventive vaccination programme may be the most effective method in protecting animals from blackleg.

Botulism

Botulism is a disease manifested by progressive muscular paralysis. It is seen in humans, animals, birds and fish and is caused by various strains of *Clostridium botulinum*.

Transmission:
Decomposed flesh and bones are the source of infection for animals. The incubation period is usually 12–24 hours, but incubation periods of anything between two hours and 14 days have been recorded.

Ante-mortem findings:
In cattle and horses:
- restlessness;
- knuckling and incoordination;
- paralysed tongue and drooling of saliva;
- sternal recumbency;
- progressive muscular paralysis from hindquarters to frontquarters, head and neck.

In sheep:
- serous nasal discharge and salivation;
- abdominal respiration;
- stiffness upon walking and incoordination;
- switching of the tail on the side;
- limb paralysis and death.

In pigs:
- lack of appetite, refusal to drink and vomiting;
- pupillary dilatation;
- muscular paralysis.

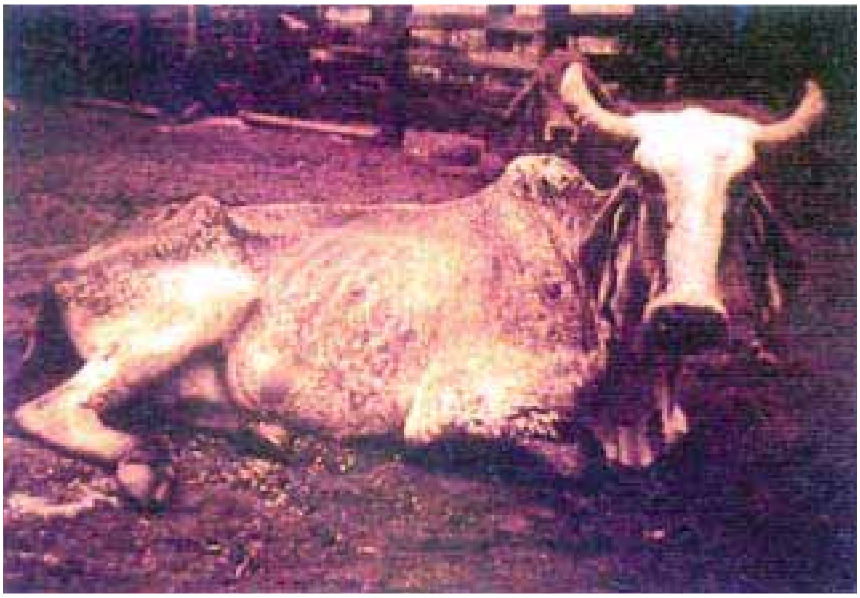
Judgement:
Total condemnation of the carcass because of human hazards.

Differential diagnosis:
Parturient paresis, paralytic rabies, equine encephalomyelitis, ragwort poisoning in horses, miscellaneous plant poisoning. In sheep: louping ill, hypocalcaemia and some cases of scrapie.

Discussion:
C. botulinum is found in the digestive tract of herbivores. Soil and water contamination occurs from faeces and decomposing carcasses. The proliferation of *C. botulinum* organisms may also occur in decaying vegetable material. Sporadic outbreaks of botulism are reported in most countries. Outbreaks of botulism in cattle and sheep in Australia, southern Africa and the Gulf Coast area of the United States of America are associated with phosphorus-deficient diets and ingestion of carrion. Cattle, sheep and rarely swine are susceptible to this disease. Dogs and cats are resistant.

C. botulinum produces a neurotoxin which causes functional paralysis. Seven strains of this organism (A through G) are distinguished according to immunological differences. The diseases caused by various strains of this agent are frequently regarded as a separate entity

PHOTO 6.14
Botulism: sternal recumbency - muscular paralysis of hind and front quarters



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owing to some of their prominent signs. Names such as Bulbar paralysis in cattle , Lamziekte in sheep in South Africa (meaning lame sickness), and Limberneck in poultry are often used. *C. botulinum* is often found in anaerobic conditions of deep wounds. It produces neuroparalytic exotoxins that cause symptoms of the disease. This organism will grow and produce toxins if the temperature is between 10 and 50 C, pH above 4.6, water activity (AW) is above 0.93 and anaerobic conditions exist. Fresh meats are implicated in less than 10 percent of botulism outbreaks. The major sources of this organism are fish, home-cured meats, home-canned vegetables and fruit. Eggs, milk and their products are rarely the cause of an outbreak. Most frequently, raw, insufficiently cooked foods or foods not fully salted, cured, dried or smoked are implicated. Botulism toxins are heat labile and food suspected of having the organism should be boiled before serving.

In humans, the signs of the disease are weakness, dizziness, blurred or double vision, dilatation of pupils, dry mouth, difficulties in breathing and speech, progressive muscular weakness, respiratory failure and death. Pneumonia may be a complication associated with botulism in humans.

Malignant oedema

Malignant oedema is a bacterial disease of cattle, sheep, goats, swine, horses and poultry. It is caused by *Clostridium septicum* and is manifested by wound infection. The infection is commonly soil-borne. Deep wounds associated with trauma provide ideal conditions for the growth of this agent.

Ante-mortem findings:

- fever 41–42 C;
- depression and weakness;
- muscle tremor and lameness;
- soft doughy swelling and erythema around the infection site.

Judgement:

The carcasses of animals affected with malignant oedema are condemned.

Differential diagnosis:

Blackleg. In malignant oedema the muscle is not involved and the wound site is noted. Anthrax in pigs. Subcutaneous oedema in the throat region is present.

Tuberculosis

Tuberculosis is a chronic disease of many animal species and poultry caused by bacteria of the genus *Mycobacterium*. It is characterized by development of tubercles in the organs of most species. Bovine tuberculosis is caused by *Mycobacterium bovis*. It is a significant zoonotic disease.

Transmission:
An infected animal is the main source of transmission. The organisms are excreted in the exhaled air and in all secretions and excretions. Inhalation is the chief mode of entry and, for calves, infected milk is an important source of infection. When infection has occurred, tuberculosis may spread: a) by primary complex (lesion at point of entry and the local lymph node) and b) by dissemination from primary complex.

Ante-mortem findings:
- low-grade fever;
- chronic intermittent hacking cough and associated pneumonia;
- difficult breathing;
- weakness and loss of appetite;
- emaciation;
- swelling of superficial body lymph nodes.

Discussion:
Mycobacteria invade cattle by respiratory (90–95 percent) and oral routes (5–10 percent). Congenital infection in the bovine foetus occurs from an infected dam. Tuberculosis lesions can be classified as acute miliary, nodular lesions and chronic organ tuberculosis. Young calves are infected by ingestion of contaminated milk. The incidence of human tuberculosis caused by *Mycobacterium bovis* has markedly dropped with the pasteurization of milk. It has also dropped in areas where programmes of tuberculosis eradication are in place. Humans are susceptible to the bovine type. In cattle, lesions of tuberculosis caused by the avian type are commonly found in the mesenteric lymph nodes. Tuberculosis in small ruminants is rare. In pigs, the disease may be caused by the bovine and avian types. Superinfection is specific in cattle.

Judgement:
The carcass of an animal affected with tuberculosis requires additional post-mortem inspection of the lymph nodes, joints, bones and meninges. It is suggested that the Codex Alimentarius judgement recommendations for cattle and buffalo carcasses be followed.

Carcasses are condemned:
- where an eradication scheme has terminated or in cases of residual infection or re-infection;
- in final stages of eradication – where natural prevalence is low;
- during early stages of eradication in high-prevalence areas.

The carcass of a reactor animal without lesions may be approved for limited distribution. If the economic situation permits, this carcass should be condemned.

Heat treatment of meat is suggested during early and final stages of an eradication programme: in low- and high-prevalence areas where one or more organs are affected, and where miliary lesions, signs of generalization or recent haematogenous spread are not observed. If the economic situation permits, then the carcass is condemned. In some countries, the carcass is approved if inactive lesions (calcified and/or encapsulated) are observed in organs and without generalization in lymph nodes of carcass.

Differential diagnosis:
Lung and lymph node abscess, pleurisy, pericarditis, chronic contagious bovine pleuropneumonia, actinobacillosis, mycotic and parasitic lesions, tumours, caseous lymphadenitis, Johne's disease, adrenal gland tumour and lymphomatosis.

Johne's disease (bovine paratuberculosis)

Johne's disease is a chronic, infectious bacterial disease of adult wild and domestic ruminants such as cattle, sheep and goats. It is characterized by the thickening and corrugation of the wall of the intestine, gradual weight loss and chronic diarrhoea, and is caused by *Mycobacterium paratuberculosis*.

Transmission:

Ingestion of faeces harbouring *M. paratuberculosis*.

- The agent is persistent in soil, pasture, manure and stagnant water for prolonged periods.
- Carrier animals, so-called faecal shedders , are the most important source of infection.
- Ingestion of organism causes infection. Calves may become infected from a nursing infected dam.
- Transmission with semen and *in utero* are minor sources of infection.

Ante-mortem findings:

- incubation: 2 to 3 years with range from 6 months to 15 years;
- poorly performing animal that stops eating in the final stages of the disease;
- gradual and chronic weight loss and emaciation;
- rough hair coat and dry skin;
- non-responsive diarrhoea with watery fluid faeces;
- submandibular oedema (bottle jaw);
- reduced milk production;
- mastitis and infertility;
- debility and death.

Judgement:

The carcass of an animal affected with Johne's disease is approved when generalized systemic signs of disease are not present. A poor, thin and slightly moist carcass should be held in the chiller and assessed after 24 or 48 hours. If the dryness and setting of the carcass improves during this time it can be released. A carcass with associated oedema and emaciation is condemned.

Differential diagnosis:

Other causes of diarrhoea and weight loss, malnutrition, chronic salmonellosis, parasitism (e.g. ostertagiasis), winter dysentery, BVD, hardware disease, coccidiosis, liver abscesses, kidney disease, inflammation of the heart and its sac, toxic inflammation of the intestine caused by arsenic, plants and mycotoxicosis and neoplasm.

Leptospirosis

Leptospirosis is an important and relatively common disease of domestic and wild animals and humans. In cattle, it is manifested by interstitial nephritis, anaemia, mastitis and abortion in most species. *Leptospira* spp. are the causative agents.

Transmission:
Animals contract the disease by eating and drinking *Leptospira*-contaminated urine or water, or by direct contact of broken skin or mucous membranes with mud, vegetation or aborted foetuses of infected or carrier animals. Recovered animals and animals with unapparent (subclinical) leptospirosis frequently excrete billions of *Leptospira* organisms in their urine for several months or years.

Ante-mortem findings:
Acute and subacute forms:

- transient fever;
- loss of appetite;
- lactating cows may stop milking;
- mastitis;
- milk may be yellow, clotted and frequently blood-stained;
- severely affected animals:
  - jaundice and anaemia
  - pneumonia
  - abortion with frequent retention of the placenta (afterbirth).

Severe illness in young calves may be associated with yellowish discoloration of mucous membranes and reddish-brown urine before death. The chronic form has mild clinical signs and only abortion may be observed. If meningitis occurs, the animal may show incoordination, salivation and muscular rigidity.

Judgement:
The carcass of an animal affected with acute leptospirosis is condemned. A chronic and localized condition may warrant an approval of the carcass.

Differential diagnosis:
Acute and subacute forms to be differentiated from babesiosis, anaplasmosis, rape and kale poisoning, bacillary haemoglobinuria, post-parturient haemoglobinuria and acute haemolytic anaemia in calves. The presence of blood in the milk is a characteristic clinical sign which will differentiate leptospirosis from other infectious diseases.

Discussion:
Leptospirosis is a zoonosis and is also an occupational hazard for farmers, veterinarians and butchers. Human infection may occur by contamination with infected urine and urine contents. The bacteria may be also found in milk in acute cases; however, it does not survive for long periods of time in milk. Pasteurization will also kill *Leptospira* organisms. They can survive for months in moist and humid environments, particularly in swamps, ponds and streams or poorly drained pastures.

Brucellosis (contagious abortion, Bang's disease)

Brucellosis of cattle is an infectious, contagious disease caused by *Brucella abortus* and is characterized by abortion in late pregnancy and a high rate of infertility. *B. melitensis* affects mainly goats, *B. ovis* sheep and *B. suis* swine. *B. abortus* may also occur in horses.

Transmission:
An uninfected animal may become infected with *Brucella* organisms by contaminated feed, pasture, water, milk, by an aborted foetus, foetal membranes and uterine fluid and discharges. The disease may also be spread by dogs, rats, flies, boots, vehicles, milking machines and other equipment used in the barn. *Brucella* organisms may be occasionally shed in urine.

Ante-mortem findings:
In cattle:

- abortion in non-vaccinated pregnant cows in the last three to four months of pregnancy;
- occasional inflammation of testes and epididymis;
- swelling of scrotum (one or both sacs);
- oedematous placenta and foetus;
- hygromas on the knees, stifles, hock and angle of the haunch, and between the nuchal ligament and the primary thoracic spines.

In sheep:

- fever, increased respiration and depression;
- inferior quality of semen in rams;
- oedema and swelling of scrotum;
- in chronic stage, enlarged and hard epididymis, thickened scrotal tunics and frequently atrophic testicles;
- infertility in rams and abortion in ewes.

D. HERENDA, CANADA

PHOTO 6.15
Brucellosis: hygromas on the knee joints - this condition may be a sequel to* Brucella abortus *infection

Judgement:
Cattle and horse carcasses affected with brucellosis are approved (after the removal of affected parts), as *Brucella* bacteria remain viable for only a short period in the muscles after slaughter. In the acute abortive form (after the miscarriage), cattle carcasses are condemned. Pig, sheep, goat and buffalo carcasses require total condemnation. Heat treatment may be recommended in some areas for these species due to economic reasons. Affected parts of the carcass, udder, genital organs and corresponding lymph nodes must be condemned.

Reactor animals should be carefully handled during slaughter and dressing procedures. Gloves and goggles should be worn when known reactors are being slaughtered and hygroma lesions should be sprayed liberally with 1% lactic acid at meat inspection.

Differential diagnosis:
Causes of abortion in cattle, IBR, vibriosis, leptospirosis, trichomoniasis, mycoplasma infections, mycosis, nutritional and physiological causes.

Discussion:
Brucella organisms have only a short life in the muscles of slaughtered animals. They are destroyed by lactic acid. While slaughtering and dressing the reactors, a hook should be used in handling the uterus and udder. Employees in close contact with infected animals should wear gloves and avoid accidental cuts.

In humans, brucellosis is called undulant fever . The general population is not at risk from this disease if high levels of hygiene and sanitation are practised. Pasteurized milk is *Brucella*-free. Affected humans will suffer from intermittent high fever, headache and generalized malaise.

Brucellosis is an important zoonosis in particular in rural areas in developing countries and is an important occupational hazard for veterinarians, meat inspectors, farmers, animal health inspectors and butchers.

Anthrax

Anthrax is a peracute disease of ruminants manifested with septicaemia, sudden death and tarry blood from the body openings of the cadaver. It is caused by *Bacillus anthracis*.

Transmission:
Humans may contract anthrax by inhalation, ingestion and through a wound in the skin. Biting flies have been shown to be transmitters.

Ante-mortem findings:
The peracute and acute forms in cattle and sheep are without clinical signs. Death may follow in the acute form after one to two hours of illness. The acute form lasts about 48 hours.

In pigs and horses this disease is usually localized and chronic and is often characterized by swelling around the throat and head.

Ante-mortem findings in pigs:
- incubation: 1–2 weeks;
- oedematous swelling of the throat and neck;
- swallowing and breathing difficulties;
- death due to choking or toxaemia;
- septicaemia is not observed.

Differential diagnosis:
Peracute blackquarter and septicaemic forms of other diseases. In splenic enlargement as seen in babesiosis, anaplasmosis and leucosis, spleen consistency is firm. In anthrax, the spleen is soft and upon incision the pulp exudes like thick blackish-red blood.

Discussion:
If an animal has died from an unknown cause in an abattoir's pen or in the stockyard, a blood smear from the tip of the ear should be examined to eliminate anthrax as a cause of death. All measures should be taken to prevent further contact with the carcass. The orifices of the nose, vulva and anus should be packed with cotton swabs to eliminate further spillage of discharge. The carcass must not be opened. As a result of insufficient oxygen supply in the closed carcass, spores of *B. anthracis* will not be formed and the organism will be killed. The spilled discharge is first removed by drying with sawdust and sand and is then destroyed together with the carcass. The carcass is wrapped in thick plastic sheets and destruction is performed under the supervision of an appropriate government official.

An open carcass facilitates exposure of *B. anthracis* to air and consequently spores are formed within a few hours. Anthrax spores are resistant to heat and disinfectants and may survive in a suitable environment for years.

An abattoir's pen or stockyard area suspected of being in contact with an anthrax animal should be disinfected with 10% NaOH or 5% formaldehyde and cleaned. This cleaning should also include the cattle trucks or cars used for the transportation of infected animals. All personnel that were in contact with anthrax, or that handled contaminated material, are also subjected to decontamination. The arms and hands should be washed with liquid soap and hot water. After they have been rinsed, they should be immersed for about one minute in an organic iodine solution or 1 ppm solution of mercuric perchloride or other acceptable agents. This is followed by a potable water rinse. Clothing of the personnel involved should also be cleaned and thoroughly disinfected by boiling.

If the carcass is discovered on the killing floor, all operations must cease. The carcass and its parts, including hides, hooves, viscera and blood must be condemned and destroyed. Carcasses that have been dressed by the same abattoir employees prior to or after the affected carcass must also be condemned and destroyed. Carcasses that had been dressed before the affected carcass may have a second option of being salvaged with sterilization. They must be boiled for a minimum of three hours if contamination occurred with blood splashes.

Disinfection of equipment used for the dressing of a diseased carcass as well as the infected abattoir area should be done with 5% solution of sodium hydroxide (NaOH). This disinfectant is used because of its action on fat and grease removal. Heat in the form of a blowtorch can be used for disinfecting buildings.

Salmonellosis in bovines

Salmonellosis is a disease that occurs in all animals and humans. In animals, salmonellosis is characterized clinically by one of three syndromes: a) peracute septicaemic form, b) acute enteritis, or c) chronic enteritis.

Young, old, debilitated and stressed animals are at greater risk. More than 200 antigenically different serotypes of *Salmonella* have been identified and all of these have pathogenic potential. The most frequently identified serotypes of the organisms that cause the disease in cattle are *S. typhimurium, S. dublin, S. muenster* and *S. newport*. Salmonellosis in stressed animals is frequently associated with inadequate diet, irregular feeding, water deprivation, overcrowding, parasitism, weather extremes, pregnancy, parturition, intercurrent diseases, etc. The calving complications that may predispose an animal to the disease include abortion or early termination of pregnancy, retained placenta, endometritis and post-parturient metabolic conditions.

Transmission:

Ingestion of feed that has been contaminated by the faeces of infected animals, by drinking-water in stagnant ponds and by contact with carrier animals. In housed animals, transmission is via contaminated feedstuff containing improperly sterilized animal by-products, such as bone-and-meat meal and fishmeal. Casual workers, infected clothing and utensils, transportation trucks and birds may transmit the disease to the farm. Active carrier animals shed *Salmonella* organisms intermittently and without obvious stress factors. Latent carriers with stress factors are also identified in the transmission of salmonellosis.

Human infection is transmitted via contaminated water, raw milk and meat. Compared to bovines, pigs and poultry are more significant sources of infection in humans.

Ante-mortem findings:

Peracute septicaemic form:

- occurs most frequently in colostrum-deficient animals up to four months of age;
- increased temperature 40.4–41.5 C;
- depression;
- diarrhoea and dehydration;
- death within 24–48 hours.

Approximately four weeks after the onset of diarrhoea:

- polyarthritis;
- meningoencephalitis;
- necrosis of distal limbs, tail and ears.

Acute enteritis:

- common form in adult cattle in late pregnancy and early postpartum;
- high temperature of 40–41 C;
- depression and loss of appetite;
- watery, foul smelling diarrhoea and dehydration;
- emaciation;
- reduced milk production and abortion;
- death.

Chronic enteritis – preceded by acute enteric form:

- further emaciation (poor doer), diarrhoea and dehydration;
- fluctuating fever (35.5–40 C).

Differential diagnosis:

Acute diarrhoea in calves: diarrhoea caused by infections (such as rotavirus, corona virus, cryptosporidiosis, *Escherichia coli*), septicaemia, dietetic gastroenteritis, coccidiosis, *Clostridium perfringens* type C enterotoxaemia.

Acute diarrhoea in adult cattle: BVD, coccidiosis, grain overload , gastrointestinal parasitism, winter dysentery, arsenic and lead poisoning, bracken fern poisoning and intestinal obstruction.

Chronic diarrhoea of adult cattle: Johne's disease, copper deficiency and gastrointestinal parasitism.

Haemorrhagic septicaemia

Haemorrhagic septicaemia is a systemic disease of cattle, buffalo, pigs, yaks and camels. It is caused by *Pasteurella multocida* type B of Carter. Outbreaks of this disease are associated with environmental stresses such as wet chilly weather and overworked, exhausted animals. It is a specific type of pasteurellosis distinct from other forms of *Pasteurella* infections.

Transmission:
By ingestion of contaminated feedstuff.

Ante-mortem findings:
- disease more severe in buffalo than in cattle;
- high fever up to 42 C;
- salivation and difficulties in swallowing;
- cough, and difficult breathing and associated pneumonia in later stages;
- oedematous swelling of throat, dewlap, brisket and peritoneum;
- diarrhoea.

Judgement:
The carcass of an animal affected with haemorrhagic septicaemia is condemned. If the disease is diagnosed on ante-mortem inspection, an animal should not be allowed to enter the abattoir. Dressing of such a carcass would create potential danger for the spread of infection to other carcasses.

Differential diagnosis:
Anthrax, blackleg, acute leptospirosis, RP, other forms of pasteurellosis, snake bite and lightning stroke.

Calf diphtheria

Calf diphtheria is an acute oral infection of calves less than three months old. It is caused by *Fusobacterium necrophorum*. This agent also causes liver abscesses and foot-rot in cattle.

Transmission:
Fusobacterium necrophorum is an inhabitant of the digestive tract of cattle and of the environment. Under unhygienic conditions, infection may be spread on feeding troughs and dirty milk pails. Some of the contributory factors for occurrence of this disease include abrasions in the oral mucosa, animals suffering from poor nutrition and other (intercurrent) diseases present in young calves.

Ante-mortem findings:
- high temperature;
- coughing;
- loss of appetite and depression;
- difficult breathing, chewing and swallowing;
- swollen pharyngeal region;
- deep ulcers on the tongue, palate, and inside of cheeks;
- pneumonia.

Judgement:
The carcass of an animal affected with local lesions is approved. Generalized diphtheric lesions associated with pneumonia or toxaemia require condemnation of the carcass. The carcass is also condemned if lesions are associated with emaciation.

Differential diagnosis:
Vesicular diseases, neoplasms and abscesses.

Actinobacillosis (“ wooden tongue”)

Actinobacillosis is a chronic disease of cattle caused by *Actinobacillus lignieresi*. It is manifested by inflammation of the tongue, less frequently of the lymph nodes, and further inflammatory lesions in the head, the viscera and the carcass.

Ante-mortem findings:

- loss of appetite;
- salivation and chewing;
- swollen tongue;
- mouth erosions;
- enlarged parotid and retropharyngeal lymph nodes.

Differential diagnosis:

Neoplasms, tuberculosis, abscesses in the lymph nodes, foreign body, salivary cysts, fungal granulomas, chronic pneumonia and parasites.

Actinomycosis (“ lumpy jaw”)

Actinomycosis is a chronic granulomatous disease of cattle and pigs and rarely of sheep and horses. It is caused by *Actinomyces bovis*, which is an obligatory parasite in the mucous membrane of the mouth and pharynx. Infection occurs following injury with a sharp object or hard feed pieces to the oral mucosa.

Ante-mortem findings:

- painful swelling of the maxilla and mandible (lumpy jaw) and, rarely, of the feet;
- suppurative tracts in the granulation tissue breaking towards oral cavity or skin;
- ulceration of cheeks and gums and wart-like granulations outward on head;
- difficult breathing and salivation;
- loss of weight;
- diarrhoea and bloat.

Judgement:

See actinobacillosis.

Differential diagnosis:

Tooth infection, impacted food, bone injury, neoplasms and osteomyelitis due to other causes.

Pyelonephritis (contagious bovine pyelonephritis)

Pyelonephritis is a purulent and inflammatory bacterial disease of the kidney, pelvis and parenchyma caused by *Corynebacterium renale*. This disease is particularly observed in adult cows and sows. A predisposing factor for developing a kidney infection is trauma to the bladder and urethra during parturition.

Transmission:

Infection is spread from clinically normal carrier cows . The organism enters via the vulva from: a) bedding contaminated with urine; b) tail swishing by carrier cows ; c) venereal transmission by infected bulls; and d) non-sterilized obstetrical instruments.

Ante-mortem findings:

- persistent increased temperature (39.5 C);
- loss of appetite and progressive weight loss;
- painful urination and increased frequency of urination;
- ammoniac odour from animal;
- acute abdominal pain (colic);
- ceased rumen contraction;
- decreased milk production.

Differential diagnosis:

Enzootic haematuria in certain areas, post-parturient haemoglobinuria, reticulitis, peritonitis, cystitis, metritis, leptospirosis, Johne’s disease, white spotted kidneys of calves, urinary obstruction, infarcts, neoplasms and hydronephrosis.

Metritis

Metritis is inflammation of the uterus. This condition is of bacterial origin. It occurs as a result of calving problems such as retention of the placenta, abortion, twin births, abnormal labour and traumatic lesions of the uterus, cervix and vagina.

Ante-mortem findings:
- high fever and depression;
- muscular weakness;
- placental retention;
- listlessness;
- reddish fetid discharge from the vulva.

Differential diagnosis:
Recent calving.

Mastitis

Mastitis is inflammation of the udder caused by bacteria, fungi and yeasts. Depending on the virulence of the agent and the resistance of the udder, mastitis is manifested in acute or chronic forms.

Ante-mortem findings:
- variable temperature depending on stage of condition;
- swollen warm, painful udder or hard enlargement involving one or all quarters;
- depression, loss of appetite and dehydration;
- abnormal gait caused by rubbing of the hind leg against inflamed quarter;
- animal tends to lie down;
- purulent or bloody exudate from teats or watery pale fluid in chronic cases.

Differential diagnosis:
Oedema, haematoma and rupture of the suspensory ligament.

Endocarditis

Endocarditis is inflammation of the endocardium of the heart. The lesion is most commonly seen in the valves. It may be the result of bacteraemia caused by infection in some remote organs such as the udder, uterus or other sites.

In cattle, the organisms most commonly associated with endocarditis are *Actinomyces pyogenes* and *Streptococcus* spp. Strains of *E. coli* are also frequently found. The lesion is most commonly found on the valves. Portions of atheromatous material may become detached and released into the bloodstream as emboli that may lodge in other organs. They may be septic or aseptic. The latter contain thrombotic material. Emboli brought from the right heart to the lungs by blood vessels may cause pulmonary abscesses, or pulmonary thrombosis, and the emboli brought from the left heart to the spleen and kidneys may cause septic or aseptic infarcts in these organs. Abscesses in the heart may also be observed.

Ante-mortem findings:
- moderate fever;
- breathing with accompanied grunt;
- pallor of mucosae;
- loss of condition and muscle weakness;
- temporary fall in milk production in lactating animals;
- jaundice and death.

Differential diagnosis:
Pneumonia, pericarditis, pulmonary oedema, emphysema, pleuritis, lymphoma, high altitude disease, congenital heart disease, congenital valvular heart cysts or deformities, especially in calves.

Traumatic reticuloperitonitis (TRP, hardware disease, traumatic gastritis, traumatic reticulitis)

TRP is caused by the perforation of the reticulum by a metallic foreign body. It is mostly seen in adult dairy cattle and can occur in beef cattle.

Ante-mortem findings:

- sudden drop in milk production;
- depression, loss of appetite and weight loss;
- stretched head and neck;
- reluctance to walk, arched back and tucked up abdomen;
- scant, hard faeces, sometimes, but rarely, covered with mucus;
- mild rumen bloat;
- audible grunt in early stages;
- if mild septicaemia develops the animal shows:
  - elevated temperature (40 C);
  - increased heart rate.

In chronic localized peritonitis, acute signs and pain lessen, temperature falls and stomach reticulo-rumen motility may return.

Differential diagnosis:

Uterine or vaginal trauma, abomasal ulceration with perforation, liver abscessation, pyelonephritis, ketosis, abomasal displacement and volvulus, and grain overload .

PARASITIC DISEASES

■ Diseases caused by helminths ■

Lungworms

Dictyocaulus viviparus is a lungworm in cattle causing verminous pneumonia or bronchitis, husk or hoose. Mature lungworms live in the bronchi. During coughing, the eggs are swallowed by the host. Hatching of eggs takes place in air passages or the digestive tract. Larvae are passed in the faeces. These will survive and develop on the ground if moist, and at moderate temperatures they become invasive in three to seven days. Larvae are resistant to cold, although their maturation will be delayed.

Upon ingestion by the primary host, larvae migrate through the intestinal wall to the mesenteric lymph nodes. From the mesenteric lymph nodes they pass via the lymphatics to the venous circulation and to the heart. From the heart they reach the lung alveoli. Three to six weeks after infection they migrate to bronchi where they mature and lay eggs. They survive seven weeks in bronchi where they terminate their life cycle.

Ante-mortem findings:

- elevated temperature (40–41 C);
- rapid shallow breathing, which in later stages becomes laboured breathing;
- nasal discharge;
- grunting;
- cyanosis and recumbency.

Judgement:

The carcass of an animal affected with lungworms is approved if infestation is slight and no secondary changes are observed. The lungs are condemned. The carcass is condemned if lungworm infestation has caused pneumonia that is accompanied by emaciation or anaemia.

Differential diagnosis:

Bacterial bronchopneumonia, abscess, necrobacillosis, tuberculosis, actinobacillosis, hydatid disease and atelectasis.

Fascioliasis

The term fascioliasis is commonly used to cover all liver flukes, but in fact there are various species. *Fasciola hepatica* is the most widespread in distribution. *Fasciola gigantica* is found in Africa and some parts of Southeast Asia, and *Fasciola magna* is found mostly in North America including Canada, and in Europe. In Zimbabwe between 30 and 70 percent of cattle slaughtered are infested with flukes. Usually the liver needs to be trimmed or condemned.

Fasciola hepatica (Photo 6.16) is the most common of liver flukes. It is leaf-shaped and measures 2.5–5 cm by 1.3 cm. It lives in the bile ducts of ruminants and other mammals.

Fasciola magna (Photo 6.17) is one of the largest flukes (10 cm by 2.5 cm), noted in the liver and rarely in the lungs of cattle, sheep, deer, moose, elk and other cervidae in Canada. It is found in North America. It may be differentiated from *Fasciola hepatica* by the absence of an anterior cone-like projection.

Fasciola gigantica is two or three times larger then *Fasciola hepatica*. It causes severe economic losses in cattle in Africa.

USDA APHIS/FSIS

PHOTO 6.16
Numerous flukes of* Fascicola hepatica *observed in the bile ducts and liver parenchyma of a cow

D. HERENDA, CANADA

PHOTO 6.17
Young fluke of* Fascioloides magna *taken from a bovine liver

Life cycle:

Each adult is hermaphroditic and produces fertilized eggs that are passed in the bile and faeces on to pasture. In the presence of water or moisture, the eggs hatch into larvae called miracidia. If the miracidia find a suitable intermediate host, which is usually the aquatic snail *Lymnaea truncatula*, they will develop into sporocysts. In different parts of the world different snails act as intermediate hosts.

The sporocysts divide to form rediae. The rediae transform into cercariae, which are the final larval stage of the cycle. They leave the snail and encyst into metacercariae. After ingestion by a herbivorous animal, the cyst wall is digested in the duodenum and the larvae cross the small intestine wall and peritoneal space to the liver. They penetrate the liver and make their way to the bile ducts and mature within a few weeks. The complete cycle of this fluke takes three to four months in favourable conditions.

Ante-mortem findings:

- weight loss and emaciation;
- fall in milk production;
- anaemia;
- chronic diarrhoea;
- swelling in the mandibular area.

Judgement:

Judgement depends on the extent of the fluke lesions and the condition of the carcass. Severe infestation with associated emaciation or oedema would necessitate total condemnation of the carcass. Mild, moderate and heavy infestation without emaciation may have a favourable judgement. If the parasitic lesions in the liver are clearly circumscribed, the liver may be salvaged after trimming off affected tissue; otherwise it is condemned.

Differential diagnosis:

Melanosis, melanoma, *Dicrocelium dendriticum* and *Gigantocotyle explanatum* infestations in Southeast Asia.

Dicrocoelium dendriticum infestation

Dicrocoelium dendriticum (the lancet fluke) is the smallest of the four mentioned flukes in the liver.

Life cycle:
Two intermediate hosts are required for its complete cycle. The eggs excreted with faeces by the final host are ingested by a land snail. Many species of land snail can act as intermediate hosts where the miracidia develop into sporocysts and cercariae. *Cionella lubrica* is the principal first intermediate host in North America.

The cercariae are expelled by the snail in mucus and are deposited on plants. They are further ingested by ants of the genus *Formica* where they develop into metacercariae. Several species of this genus can act as second intermediate hosts. In North America *Formica fusca* is the second intermediate host.

Ruminants, while grazing, may ingest these ants. The cyst wall of the metacercariae is digested and larvae then migrate to the bile ducts where they mature. *Dicrocoelium dendriticum* is only slightly pathogenic and does not produce clinical symptoms in the animal.

Judgement and differential diagnosis:
See fascioliasis.

Oesophagostomiasis (pimply gut, nodular worms)

Oesophagostomiasis is a parasitic disease of ruminants and swine. *Oesophagostomum radiatum* is found in cattle, *Oesophagostomum columbianum* in sheep and *Oesophagostomum dentatum* in swine. The larvae in these species are found in the intestine, caecum and colon. In some southern African countries the parasite may affect 5–10 percent of cattle, sheep and pigs.

Life cycle:
The larvae develop to the infective stage on pasture. They are sensitive to cold, dryness and temperature changes. The infected larvae penetrate the intestinal mucosa and many of them become encysted. The larvae that penetrate into deeper mucosal layers provoke an inflammatory reaction and nodules of pimply gut . Further stages of development occur in the intestinal wall. It is believed that many larvae are killed by the reaction they provoke in the intestine. When the larvae leave nodules due to malnutrition or lower resistance of the animal, they reach the colon. In the colon they become adults and attach themselves to the colonic mucosa where they lay eggs. A great number of nodules appear as gross lesions after the departure of larvae. With repeated parasitic exposure, the host becomes immune and resistant to these larvae and local intestinal reaction becomes granulomatous. The nodules that surround dead larvae and those which calcify after caseation are persistent and they protrude from the intestinal wall. This may explain why nodules are present in adult animals and why no adult worms are observed in the intestinal lumen. In young animals that have no immunity, adult worms are present in the lumen of the intestine and nodules are lacking. There are some adults with both nodules and adult worms in the intestine. *O. columbianum* in sheep may cause extensive formation of nodules, which may become suppurative and may rupture. This leads to inflammation of the peritoneum and adhesions.

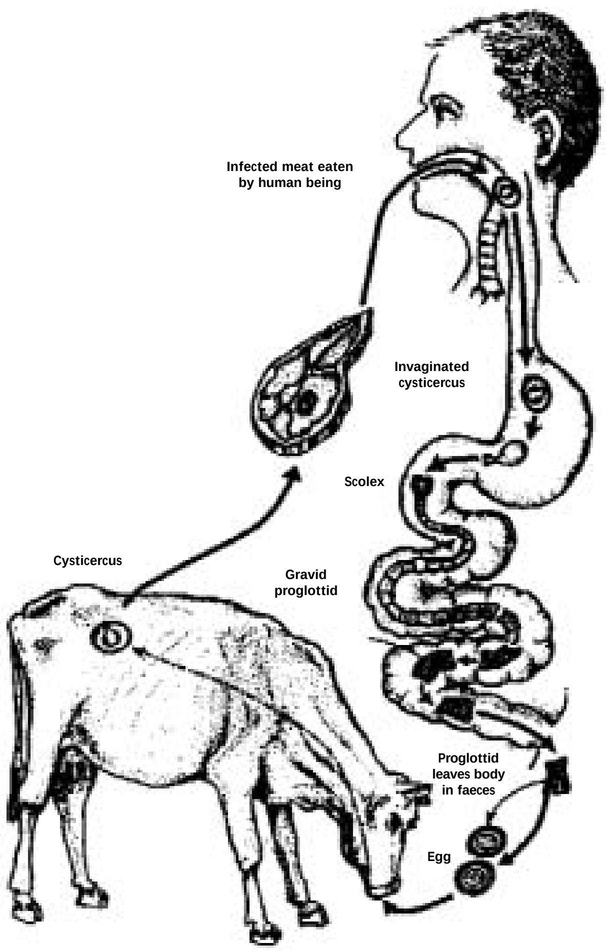
Ante-mortem findings:
- diarrhoea with black-green faeces which may be mixed with mucus and blood;
- loss of condition and emaciation;
- stiff gait;
- young calves may show loss of appetite, diarrhoea, emaciation and anaemia.

Cysticercosis

Bovine cysticercosis is caused by *Cysticercus bovis*, which is the cystic form of the human tapeworm *Taenia saginata*.

Life cycle:
Cysticercus bovis is the larval stage of *T. saginata*. *T. saginata* may grow from 3 to 7 m in length and lives in the intestine of humans. It consists of a suckered head called scolex which is attached to the intestine. It also consists of a neck and hundreds of proglotid segments. Mature proglotids are filled with eggs. The proglotids break off and are excreted in the faeces where they fragment and release the ova. Cattle become infected by grazing on ground and by the digestion of foodstuff contaminated with human faeces. The oncosphere liberated in the intestine from the egg penetrates the intestinal wall and through the lymphatics and bloodstream reaches the skeletal muscles and heart. In the muscles the oncosphere develops into the intermediate or cysticercus stage containing a scolex. The sites of predilection are the masseter muscles, tongue, heart and diaphragm. In some countries in Africa the cysticerci appear to show uniform distribution in the musculature. If ingested by humans, the final or definite host, the scolex attaches itself to the intestinal wall and tapeworms then develop and mature (Figure 6.1).

FIGURE 6.1 **The life cycle of *Taenia saginata***



Source: G.J. Jackson, Division of Microbiology, US FDA, Washington, DC.

Transmission:
Infection in humans occurs following consumption of raw or undercooked beef containing viable cisticerci. Cattle become infected by ingestion of feedstuff containing ova passed from infected humans. Cattle raised on free range often become infected through contamination of grazing with human faeces. Infected farm workers may contaminate hay, silage, other feeds or sewage effluent. Intrauterine infection of a bovine foetus has also been recorded.

Ante-mortem findings:
Heavy infestation in cattle may show:
- muscle stiffness;
- rarely fever.

Differential diagnosis:
Hypoderma species (migration to heart), nerve sheath tumour, eosinophilic myositis, abscess and granuloma caused by injections.

Hydatid disease (hydatidosis, echinococcosis)

Hydatid disease in cattle is caused by the larval stages of the 2–7 mm long tapeworm *Echinococcus granulosus*, which lives in the intestines of dogs and other carnivores. Several strains of *E. granulosus* exist – the cattle/dog strain is primarily responsible for hydatid disease in cattle. In Africa, hydatid disease is reported more commonly in cattle that are communally owned or are raised on free range, and which associate more intimately with domestic dogs. Hydatidosis in domestic ruminants inflicts enormous economic damage because of the condemnation of affected organs and lowering of the meat, milk and wool production.

Life cycle:
The infective eggs containing the oncosphere passed in the faeces are accidentally ingested by cattle, sheep, pigs, other animals or humans, which act as intermediate hosts. After the infective eggs are ingested by these intermediate hosts, the oncospheres in the eggs penetrate the intestine and reach the liver, lungs and other organs, including the brain and muscles, to develop into hydatid cysts after about five months. These cysts commonly measure 5–10 cm and contain fluid. Some may reach up to 50 cm in diameter. Others may produce daughter cysts. The diagnostic features of hydatid cysts are a concentrically laminated thick outer layer within which is a germinal layer. In fertile hydatids, the germinal layer is granular and has brood capsules each containing protoscoleces. When brood capsules become detached and float free in the cysts' fluid they are referred to as hydatid sand. In some animals a fair proportion of hydatids may be sterile. The life cycle is completed when a fertile hydatid cyst is eaten by a definitive host, a dog or appropriate carnivore. Cattle and the majority of intermediate hosts show no clinical evidence of infection. However, in humans hydatid cysts can cause serious disease.

Ante-mortem findings:
None of significance.

Judgement:
A carcass showing emaciation, oedema and muscular involvement is condemned and destroyed. Otherwise the carcass is approved. Affected viscera and any other tissue are also condemned and destroyed. Burying of carcasses is not sufficient, since dogs may retrieve the affected organs.

Differential diagnosis:
Retention cysts in kidneys, cysts in liver, granulomatous lesions, *Cysticercus tenuicolis* and tuberculosis.

Onchocercosis

Onchocercosis in cattle is caused by nematodes of the genus *Onchocerca*. Several species are involved, but the most important species is *Onchocerca gibsoni*, which causes subcutaneous nodules or worm nests in cattle in some countries of the Asia–Pacific region and southern Africa.

Life cycle:
The adult worm lives in the nodules and the fertilized females liberate microfilariae into the tissue lymph spaces from where they are taken up by an insect vector that acts as an intermediate host. Midges of the genus *Cullicoides* are common vectors. Other biting flies can act as intermediate hosts. The larvae develop to the infective stage in these insect vectors. Infection of cattle occurs when these biting flies with infective larvae feed on them.

Ante-mortem findings:
Careful palpation reveals subcutaneous nodules in the brisket and buttock regions.

Differential diagnosis:
Abscesses, neurofibromatosis, cysticercosis, eosinophilic myositis.

■ Diseases caused by protozoa ■

Trypanosomiasis

This is a protozoan disease of animals and humans caused by parasites of the genus *Trypanosoma*, which are found in blood plasma, various body tissues and fluids.

Transmission:
Trypanosomes (*Trypanosoma* spp.) are transmitted primarily by the *Glossina* spp. (tsetse flies), *Stomoxys* spp. (stable flies), Tabanidae (horseflies) and Reduviidae (assassin bugs), and by venereal contact. Trypanosomes in the insect vector undergo one or two cycles of development.

Ante-mortem findings:
- intermittent fever;
- anaemia;
- weight loss and weakness;
- oedema, particularly observed in the face and legs;
- enlarged body lymph nodes;
- haemorrhage;
- opacity of the cornea, keratitis and photophobia;
- chronic form of trypanosomiasis is sometimes manifested by progressive weakness, despite absent parasitaemia, and death.

Judgement:
The carcass affected with trypanosomiasis or any other protozoan diseases is condemned if an acute condition is associated with systemic body changes. Heat treatment may be recommended in some cases if economically feasible. The carcasses of recovered and reactor animals may be approved if generalized lesions are lacking. A carcass showing borderline emaciation or slight oedema should be examined after 24–48 hours in the chiller. A satisfactory setting would lead to a favourable judgement of the carcass. The affected parts of the carcass and organs are condemned.

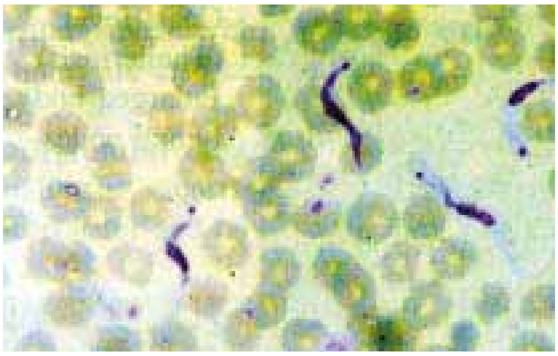
Differential diagnosis:
Helminthiasis, malnutrition and other chronic wasting diseases, equine infectious anaemia, heartwater, babesiosis and anaplasmosis.

P.G. CHAMBERS, ZIMBABWE

PHOTO 6.18
Trypanosomiasis: this animal shows icteric mucous membranes, weakness in leg muscles and emaciation

J. THORSEN, UNIVERSITY OF GUELPH, CANADA

PHOTO 6.19
An impression smear of the trypanosomes and the red blood cells in the capillaries



J. ZAUGG, UNIVERSITY OF IDAHO, USA

PHOTO 6.20
Trypanosoma vivax *in blood smear*

Theileriosis (East Coast fever)

East Coast fever is a subacute haemoprotozoan disease of cattle caused by *Theileria parva*. Theileriosis is characterized by fever, enlarged lymph nodes, dyspnea and death. In chronic cases loss of condition, emaciation, diarrhoea, blindness, etc. can be seen.

Transmission:
Vectors are ixodid ticks of the species *Rhipicephalus*.

Ante-mortem findings:
- mortality up to 90 percent;
- high temperature (up to 41 C);
- difficult breathing and coughing;
- nasal discharge, salivation and watery eyes;
- swelling of the lymph nodes draining the area where the infected tick fed (Photo 6.21);
- cerebral signs manifested by circling to one side, convulsions and death.

Judgement:
The carcass and viscera of an animal affected with febrile chronic theileriosis and without systemic lesions are approved.

The carcass is condemned, if acute febrile theileriosis is accompanied with fever and generalized lesions. The affected organs are also condemned.

Differential diagnosis:
Haemorrhagic septicaemia, babesiosis, MCF, trypanosomiasis, Rift Valley fever, heartwater and bovine leukosis.

P.G. CHAMBERS, ZIMBABWE

PHOTO 6.21
East Coast fever (theileriosis): enlarged body lymph nodes

Besnoitiosis

Besnoitiosis is a chronic debilitating protozoan disease of cattle and horses. It also occurs in wild animals such as antelope and wildebeest (gnu) in Africa and caribou in Canada. The causative agent in cattle is *Besnoitia besnoiti* and *Besnoitia benetti* in horses.

The organism is closely related to the genus *Toxoplasma.* The mode of transmission is still unknown. It is believed that tabanids are mechanical vectors.

Ante-mortem findings:
- elevated temperature;
- increased respiration;
- nasal discharge and lacrimation;
- diarrhoea;
- cysts in the skin and subcutaneous tissue and loss of hair;
- swollen body lymph nodes;
- severe generalized oedema of the head, neck, ventral abdomen and legs;
- chronic skin lesions show in folding and cracking;
- decreased milk production;
- inflammation of the testicles.

Judgement:
The carcass is approved if the lesions are localized with no systemic involvement. The carcass is condemned if disseminated, generalized lesions are accompanied with emaciation.

Differential diagnosis:
Lumpy skin disease, sweating sickness and ectoparasitism (mites, ticks, fungi).

Anaplasmosis (gall sickness)

Anaplasmosis is a disease caused by a rickettsia-like organism and characterized by severe debility, emaciation, anaemia and jaundice. It is caused by *Anaplasma* spp. They are obligate intraerythrocytic parasites. *Anaplasma marginale* is the causative agent in cattle and wild ruminants.

Transmission:
Ticks of the genus *Boophilus* transmit anaplasmosis. Mosquitoes and horseflies are mechanical transmitters. Transmission is also possible through injection needles.

Ante-mortem findings:
Acute infection with *A. marginale:*

- high fever;
- jaundice and anaemia demonstrated by pale mucous membranes;
- frequent urination and constipation.

Chronic infection:

- emaciation.

Judgement:
The carcass of an animal showing acute infection should be condemned. Recovered and suspect animals manifesting inconclusive signs of anaplasmosis are approved if otherwise healthy.

A mildly yellow discoloured carcass may be chilled and assessed after setting. If the discoloration has disappeared, the carcass is approved. Animals affected with anaplasmosis could be treated under the supervision of a government official. Guidelines for the withdrawal period for therapeutic agents should be followed if the animals are being shipped for slaughter.

Differential diagnosis:
Icterus and anaemia of different causes, anthrax, leptospirosis, emaciation caused by parasitism and malignant lymphoma, babesiosis.

Remarks:
The access of biting insects to contaminated fresh blood should be prevented. Blood from suspicious carcasses should not be salvaged.

Babesiosis (piroplasmosis, Texas fever, red water fever, tick fever)

Babesiosis of cattle, horses, sheep and swine is a febrile, tick-borne disease caused by various species of the protozoan genus *Babesia*.

Transmission:
Different species of ticks in the family Ixodidae serve as vectors in different locations. The *Babesia* parasites can be transmitted transstadially and transovarially within a tick species.

Ante-mortem findings:

- incubation: 7–10 days;
- mortality up to 50 percent or over depending on age, breed, etc;
- high fever (41.5 C);
- dark reddish brown urine in the terminal stage;
- reddened and injected mucous membranes at the early stages and later, anaemic mucous membranes;
- clinical signs may resemble rabies in cerebral form of babesiosis.

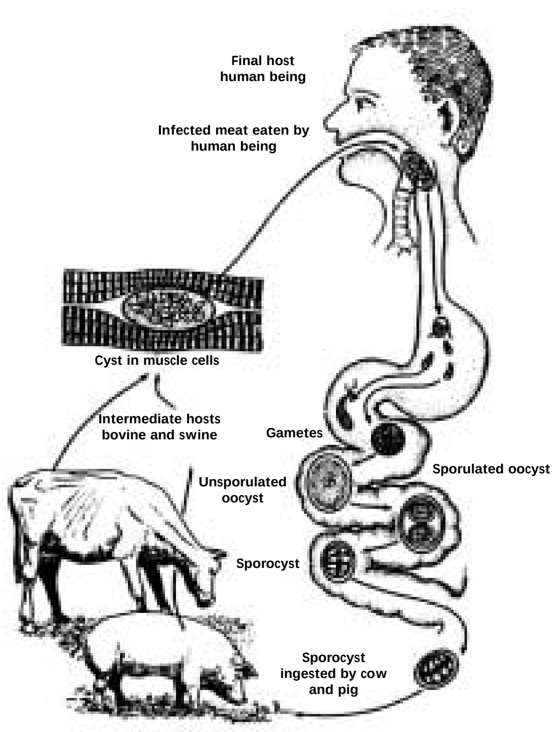
Judgement:
The carcass of an animal in the acute form of the disease, with associated icterus, is condemned. An emaciated, jaundiced carcass showing yellow gelatinous fat also requires total condemnation. A mild form of this disease showing yellow or orange coloration of the carcass, not associated with icterus, may be approved. The satisfactory setting of the carcass in the chiller must be considered in this approval.

Differential diagnosis:
Anaplasmosis, trypanosomiasis, theileriosis, leptospirosis and bacillary haemoglobinuria.

Sarcocystosis (sarcosporidiosis)

Sarcocystosis is caused by the various species of the protozoan genus *Sarcocystis*. This is one of the most common parasitic conditions in domestic food animals and a high percentage of cattle in various parts of the world are infested with these parasites, which are usually host-specific. In cattle, three species have been recognized. They are listed in Table 6.1. Cattle are the intermediate hosts of *Sarcocystis* spp. All *Sarcocystis* spp. in the intermediate hosts, the food animals, are characterized by the formation of cysts in the muscles.

FIGURE 6.2 **The life cycle of *Sarcocystis hominis* (cattle) and *Sarcocystis suihominis* (pigs) in the final host (humans)**



Source: G. J. Jackson, Division of Microbiology, US FDA, Washington, DC.

Life cycle:

All *Sarcocystis* spp. require two hosts and a pre-predator cycle to complete their life cycle. A herbivore – the prey – and a carnivore or omnivore – the predator – are involved. Sexual development occurs in the predator, which is therefore a definitive host, and asexual development occurs in the prey, which is the intermediate host. Two species, one in cattle (*S. hominis*) and one in pigs (*S. suihominis*), use humans as definitive hosts and therefore these infections in animals are zoonoses (Figure 6.2). Generally speaking, dog-transmitted *Sarcocystis* are pathogenic, whereas cat-transmitted ones are not.

The most important species in cattle is *S. cruzi*, which has worldwide distribution and uses the dog as the definitive host. Sexual development takes place in the dog after which infective sporocysts are passed in the faeces. The details of development in cattle are illustrated in Figure 6.3.

The buffalo is the intermediate host for two species: *S. levinei*, which forms microscopic cysts and uses the dog as the definitive host, and *S. fusiformis*, which forms macroscopic spindle or globular-shaped cysts measuring 32 mm x 8 mm and uses the cat as the definitive host.

TABLE 6.1 ***Sarcocystis* spp. in cattle**

Species	Distribution	Definitive host/s	Size of cyst	Pathogenicity
S. cruzi	Worldwide	Dog, coyote, red fox, raccoon and wolf	Microscopic, less than 0.5 mm long	Most pathogenic species; in cattle it can cause fever, anaemia, abortion, neurological signs and even death
S. hirsuta	Probably worldwide	Cat	Macroscopic, up to 8 mm long and 1 mm wide, fusiform in shape	Mildly pathogenic
S. hominis	Europe	Humans and some primates	Microscopic	Mildly pathogenic to cattle

S. fusiformis cysts are seen in the oesophagus and the skeletal musculature and are common parasites of the water buffalo in many parts of the world.

Transmission:

Cattle acquire infection by ingesting sporocysts contaminating feed, pasture or water. After several generations of asexual reproduction by schizogony, they form cysts in muscles. *S. cruzi*, the most pathogenic species for cattle, forms microscopic cysts. The definitive hosts, including humans, acquire the infection when they eat bovine tissues containing the viable *Sarcocystis* cysts. The data provided below are for *S. cruzi* infestations, unless specified otherwise.

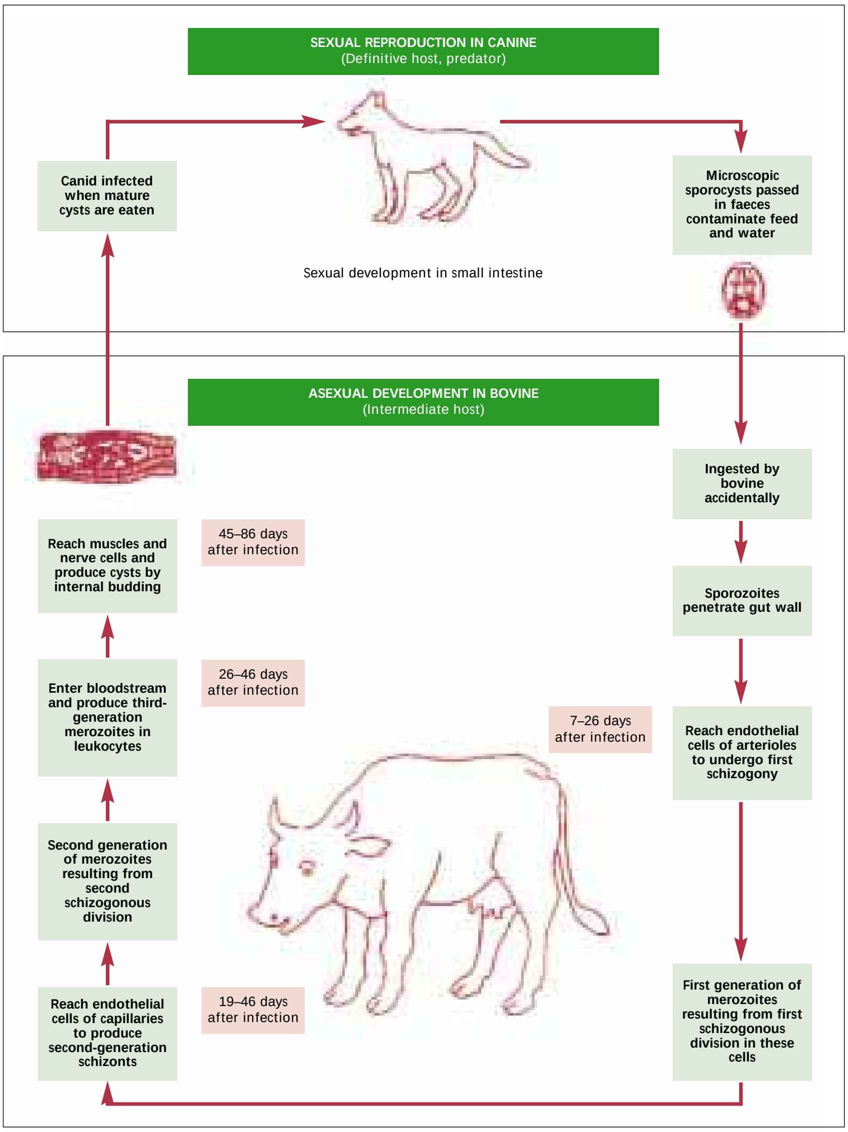
Ante-mortem findings:

- incubation: 5–11 weeks;
- fever;
- loss of appetite;
- excessive salivation;
- anaemia;
- abortion;
- loss of hair, especially at the tip of the tail.

Differential diagnosis:

Cysticercosis, toxoplasmosis, neurofibromatosis, eosinophilic myositis.

FIGURE 6.3 **The life cycle of *Sarcocystis cruzi* in the bovine and canine (prey-predator cycle)**



Source: P. Seneviratna, Australia.

■ Diseases caused by arthropod parasites ■

Hypoderma bovis infestation

There are two warble flies in cattle, *Hypoderma bovis* and *Hypoderma lineatum*. They have similar cycles. During the summer, the adult fly lays its eggs on the leg hair and occasionally on the body of cattle. Within a week the larvae hatch and burrow into the skin and, for several months, they travel through the body. *H. bovis* migrates into the thoracic and abdominal cavities towards the spinal canal before moving under the skin of the back. *H. lineatum* migrates to the oesophageal area before reaching the dorsal area of the animal. In spring (February–May), the larvae reach the area of the back. They burrow a breathing hole and increase in size to approximately 8 mm x 25 mm. They are visible for a month. After this cycle, maggots fall to the ground where they develop into flies and start the whole cycle once again (Figure 6.4).

MOSBY YEAR-BOOK INC., USA

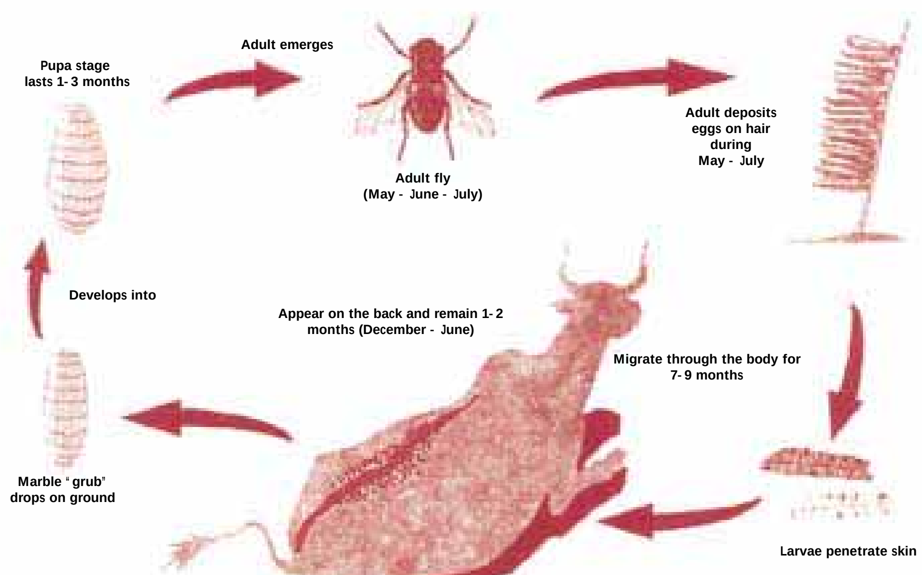
PHOTO 6.22
Hypoderma bovis: ***larvae protruding from back in a two-year-old steer***

Ante-mortem findings:
- swelling or eroded skin on the back;
- larvae protruding from the skin of the back (Photo 6.22);
- cattle may rush violently and kick the abdomen with hind legs;
- erected tail;
- paralysis of the lower body and legs if the spinal cord is involved.

Judgement:
The carcass of an animal affected with *H. bovis* is approved. Subcutaneous lesions are removed.

Differential diagnosis:
Cysticercus bovis cysts in oesophagus.

FIGURE 6.4 ***Hypoderma bovis*: life cycle of warble fly in cattle**



Source: M. Vargas Teran, FAO.

Screwworm myiasis

Screwworm myiasis caused by larvae of the flies *Cochlliomyia hominironux* (New World screwworm – NWS) and *Chrysomya bezziana* (Old World screwworm – OWS) is characterized by larvae feeding on living tissues in open wounds of any warm-blooded host, including humans, resulting in weight loss, other signs of morbidity and sometimes death. NWS is found in Central and South America, including the Caribbean region. OWS is located in India, Southeast Asia, tropical Africa and in the Persian Gulf area.

Life cycle:
In the preferred temperature range (20–30 C) it is about 21 days. The female, which mates only once, lays one or more batches of up to 300 eggs at the edge of any wound or break in the skin in any warm-blooded animal. Skin breaks as small as tick-bites, as well as natural orifices, can be sites of oviposition. The larvae develop within 24 hours, and burrow into the living flesh, creating large, deep, open wounds that attract further egg-laying females. If unattended, these wounds are often fatal, particularly in newborn animals where the oviposition site is usually the navel (Figure 6.5).

Ante-mortem findings:
A serosanguinous discharge often exudes from the infested wounds (Photo 6.23), and a distinctive odour may be detected. In some cases, the openings in the skin may be small with extensive pockets of screwworm larvae beneath (Photo 6.24). In dogs, screwworm larvae commonly tunnel under the skin. Screwworm infestations in anal, vaginal and nasal orifices may be difficult to detect, even in the later stages.

Differential diagnosis:
Other blow flies such as *Compsomyia macellaria* and *Sarcophagidae* spp.

FIGURE 6.5 **The life cycle of the screwworm**

Source: M. Vargas Teran, FAO.

M. VARGAS TERAN, FAO

PHOTO 6.23
Wound of adult bovine infested by NWS

M. VARGAS TERAN, FAO

PHOTO 6.24
Typical pocket-like wound from screwworm larvae

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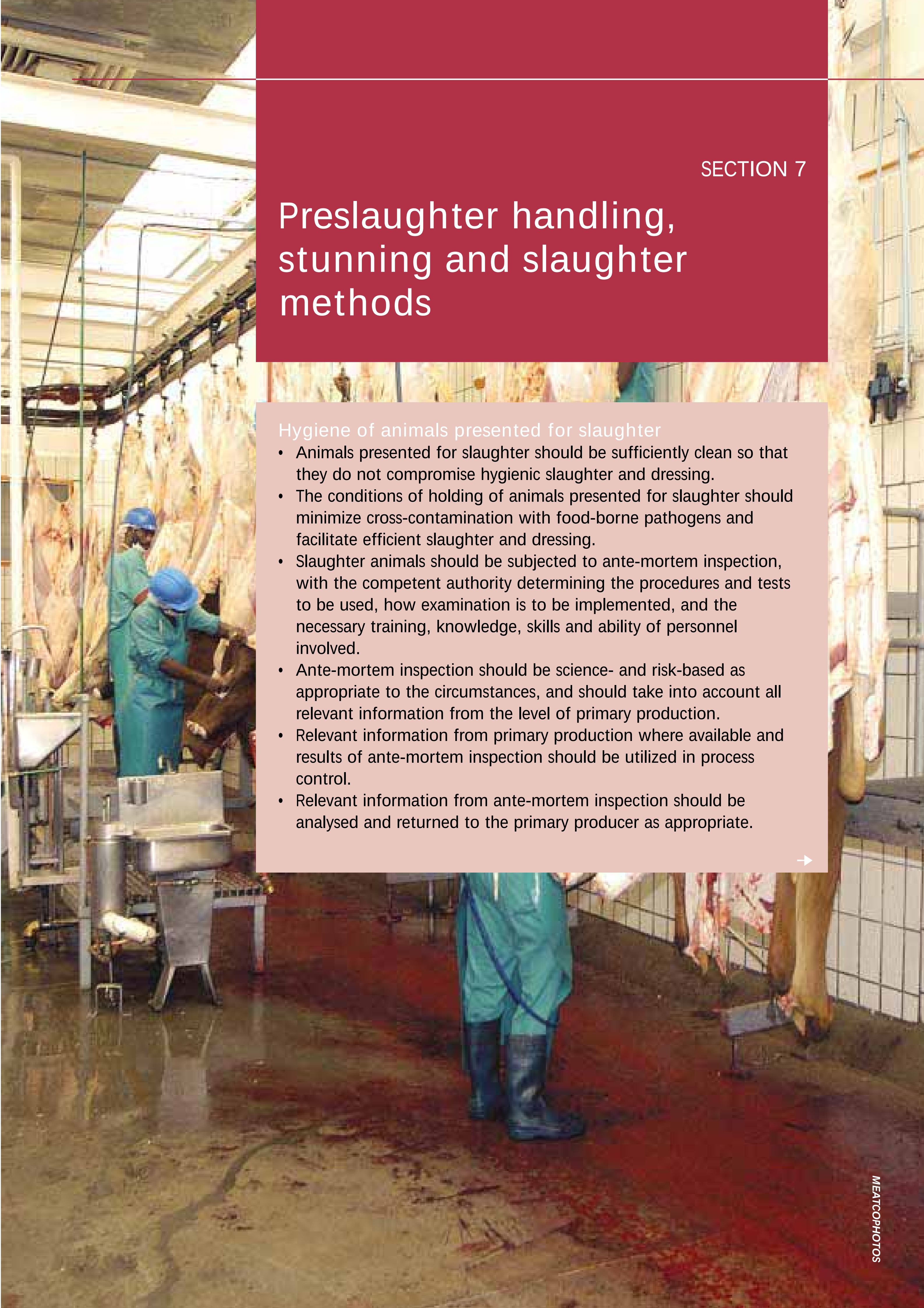


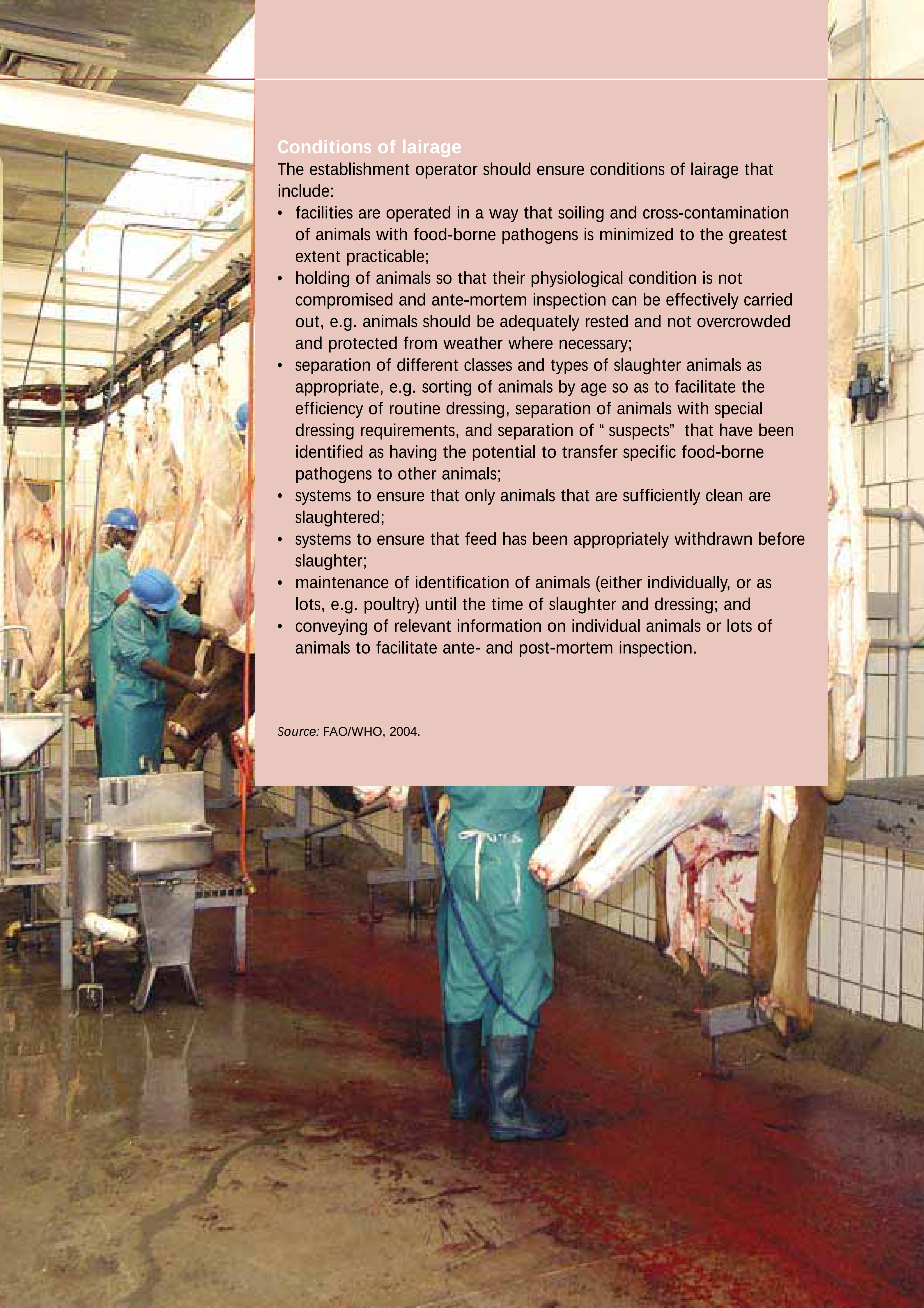
MEATCOPHOTOS

SECTION 7

Preslaughter handling, stunning and slaughter methods

Hygiene of animals presented for slaughter

- Animals presented for slaughter should be sufficiently clean so that they do not compromise hygienic slaughter and dressing.
- The conditions of holding of animals presented for slaughter should minimize cross-contamination with food-borne pathogens and facilitate efficient slaughter and dressing.
- Slaughter animals should be subjected to ante-mortem inspection, with the competent authority determining the procedures and tests to be used, how examination is to be implemented, and the necessary training, knowledge, skills and ability of personnel involved.
- Ante-mortem inspection should be science- and risk-based as appropriate to the circumstances, and should take into account all relevant information from the level of primary production.
- Relevant information from primary production where available and results of ante-mortem inspection should be utilized in process control.
- Relevant information from ante-mortem inspection should be analysed and returned to the primary producer as appropriate.



Conditions of lairage

The establishment operator should ensure conditions of lairage that include:

- facilities are operated in a way that soiling and cross-contamination of animals with food-borne pathogens is minimized to the greatest extent practicable;
- holding of animals so that their physiological condition is not compromised and ante-mortem inspection can be effectively carried out, e.g. animals should be adequately rested and not overcrowded and protected from weather where necessary;
- separation of different classes and types of slaughter animals as appropriate, e.g. sorting of animals by age so as to facilitate the efficiency of routine dressing, separation of animals with special dressing requirements, and separation of " suspects" that have been identified as having the potential to transfer specific food-borne pathogens to other animals;
- systems to ensure that only animals that are sufficiently clean are slaughtered;
- systems to ensure that feed has been appropriately withdrawn before slaughter;
- maintenance of identification of animals (either individually, or as lots, e.g. poultry) until the time of slaughter and dressing; and
- conveying of relevant information on individual animals or lots of animals to facilitate ante- and post-mortem inspection.

Source: FAO/WHO, 2004.

INTRODUCTION

When animals are killed for food, it is imperative for ethical reasons that the methods used do not inflict pain. To comply with this requirement, animals should be rendered insensible before slaughter. The period of insensibility must include the time when it is initiated, through the start of the slaughter process to the time taken for the animal to bleed to death. In most instances, except for certain forms of religious slaughter, insensibility is achieved by stunning the animals prior to slaughter.

In each of the methods that are used for stunning and slaughtering animals, there should be means of verification that the processes were adequately carried out. Care should be taken to protect operators during potentially hazardous processes. Furthermore, principles of meat hygiene should be strictly adhered to in order to prevent any contamination of edible parts of the carcass.

The length of time animals spend in the lairage awaiting slaughter varies according to the abattoir's work practices and throughput, but should not exceed 72 hours if in a covered part of the slaughterhouse. In practice, the average time will usually be only a few hours. Following this period, when the animal should be resting, it is moved from the holding pen to the stunning pen or area, a process that should induce minimal stress (to both animal and stock handler).

ANIMAL RESTRAINT TO FACILITATE STUNNING AND/OR SLAUGHTER

Animals have to be transferred from the lairage pens either directly or through a race into an area where stunning and slaughter are carried out (see Section 5). Animals are often transferred from the lairage through a race to the stunning area. The race design should take into account animals' natural instincts and normal behaviour. Race designs incorporating solid, smooth sides and walls, and non-slip flooring work well. Curved races with no dead ends facilitate smooth movement of animals. Adequate lighting in the race also improves animal movement. Goading in the race should be as minimal as possible.

In order to facilitate stunning and to protect the operators, some kind of restraint is necessary. Restraint should allow correct application of stunning equipment and protect animal welfare, as well as protecting operators from potential injury, especially from large animals. This may be achieved in a number of ways.

Manual restraint in an open pen

This is usually done by manually handling the free standing animal in an open area or a pen. The animal may enter the pen either directly from holding areas or through raceways. Electrical or captive bolt stunning in pigs and sheep and religious slaughter (Photo 7.1) can be carried out this way. However, safety and

PHOTO. 7.1
Restraint by shackle before religious slaughter

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PHOTO 7.2
Upright cattle restraint with monorail conveyor a) Chin lift, b) Monorail, c) Neck restraint

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PHOTO 7.3
Upright cattle restraint with monorail (internal view) a) Chin lift, b) Monorail, c) Neck restraint

welfare problems may be common, especially when handling cattle.

Restraint in a squeeze/crush pen

This method involves holding the animal by pressure from the sides. Usually one side moves. It is not commonly used.

Cattle stunning pens

Different designs of cattle restraint pens can be used. The objective is to confine the animal in a pen so that stunning and slaughter can be carried out effectively and safely. Animals usually enter the pen after going through a race. The race should have smooth curved sides if they are long, and have sufficient light. Use of prods should be minimal. Pens must have gates to close after entry.

For captive bolt stunning, facilities to present the head for correct stunning at the front are useful. Some cattle pens are specially constructed for captive bolt or electrical stunning and/or religious slaughter. Upright (Photos 7.2 to 7.4) and Facomia pen (Photo 7.5) designs have additional features for extra restraint, such as a belly lift, back push and chin lift. The Facomia pen tilts the animal to approximately 45 . Rotary pens that turn the animal 180 (i.e. upside down) are more stressful and are banned in the United Kingdom.

V-type restrainers

V-type restrainers use the principle of suspending the animals in a funnel-shaped apparatus, which often has a conveyor system and is commonly used for pigs and sheep. It seems to work better for sheep than pigs. Sheep can be electrically stunned, either head only or head-to-back at the end of the conveyor, either manually or automatically (Figure 7.1).

Monorail restrainers

This system holds the animal in a straddle position over a rail. When combined with a conveyor system, animals are moved to the point of stunning with possibly less stress than with V-restraint. This system is successfully used for pigs (Figure 7.2).

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PHOTO 7.4
Upright cattle restraint: exsanguination by religious method
a) Chin lift, b) Monorail, c) Neck restraint

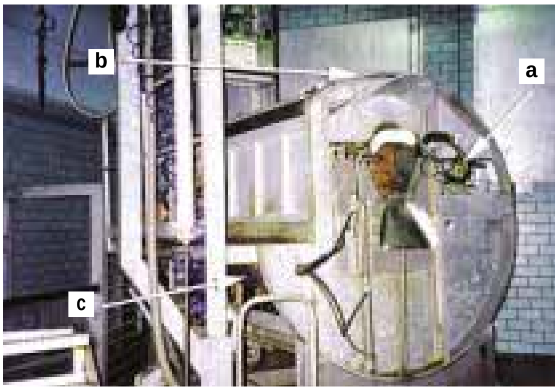

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PHOTO 7.5
Facomia cattle pen
a) Chin lift, b) Rotating pen (45), c) Belly lift

PRESLAUGHTER STUNNING

Animals must be stunned before slaughter by an appropriate, recognized stunning method that must produce immediate unconsciousness that lasts until death. Animals should be restrained prior to stunning if it improves the effectiveness of the stunning procedure, but they must not be restrained unless they can be stunned and slaughtered without delay. Also, stunning must not be carried out unless the animal can be slaughtered without delay. Operators must be trained and competent to carry out and recognize effective stunning. The assessment of stunning must take place before any other procedure is carried out. Spare stunning or killing equipment must always be available for immediate use.

Electrical stunning

Electrical stunning equipment must be capable of producing an effective stun for the species and size of the animal. Electrodes must be placed so that they span the brain (Figures 7.3 and 7.4) and sufficient voltage ($>$ 200 volts) applied for $\geq$ 3 seconds to cause immediate unconsciousness. When sufficient current is applied to the brain, an epileptic fit will be produced during which the animal is unconscious.

FIGURE 7.1 **V-type restraint conveyor for sheep**

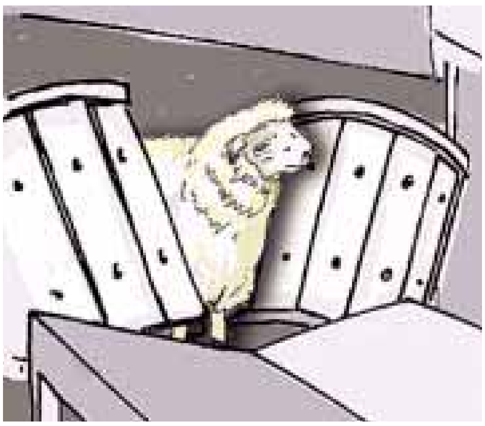

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FIGURE 7.2 **V-type restraint conveyor for pigs**

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FIGURE 7.3 **Good practice: optimum tong position for head-only electrical stunning of pigs**

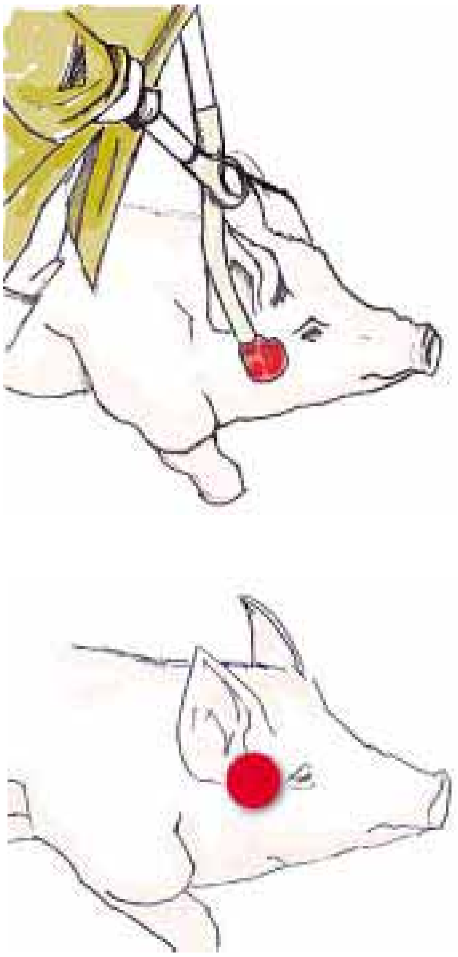

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TABLE 7.1 **Recommended minimum currents for head-only stunning of red meat species**

Species	Minimum current to stun (amps)
Pigs	1.3
Sheep and goats	1.0
Lambs/kids	0.6
Calves	1.0
Cattle	1.2

The relationship between Voltage (V), Current (I) and Resistance (R) is given by the formula: V = I x R. Therefore, the resistance between the electrodes will affect the induced current. The electrode/animal interface forms a major part of the overall resistance and, thus, the condition of the electrodes must be regularly inspected and maintained. The recommended minimum current to stun is given in Table 7.1.

Head-only stunning tongs (pigs, sheep, goats and calves) should be fitted with electrodes that contain two parallel rows of teeth that are sharp enough to penetrate the outer layers of skin and to ensure that the electrodes do not slide following initial contact, thus maintaining the continuity of the current application. Electrical stunning equipment must contain an ammeter and voltmeter display.

Electrical stunning equipment should be used and maintained according to the manufacturer's instructions and must not be used to immobilize, restrain or goad an animal. The operator must be trained and competent to carry out the stunning procedure and the electrodes must be placed accurately on the animal's head and for the required duration.

The following are signs of an effective electrical stun:

- Tonic phase (duration 10–12 seconds):
  - animal collapses and becomes rigid;
  - no rhythmic breathing;
  - forelegs extended and hindlegs flexed into the body.
- Clonic phase (duration 20–35 seconds):
  - uncontrolled kicking or paddling movements;
  - eye roll or flicker and salivation.

The clonic phase will be followed by the return of rhythmic breathing and subsequent recovery in an unbled animal. Therefore, effective stunning and slaughter can be characterized by the absence of rhythmic breathing from the initiation of the stun through to the death of the animal (through correct sticking).

Mechanical stunning

The objective of mechanical stunning methods is to induce immediate unconsciousness by the administration of a severe blow to the head of the animal. The unconsciousness produced must last until death. Mechanical stunning devices (nowadays, almost universally captive bolt guns

FIGURE 7.4 **Good practice: optimum tong position for head-only electrical stunning of sheep**

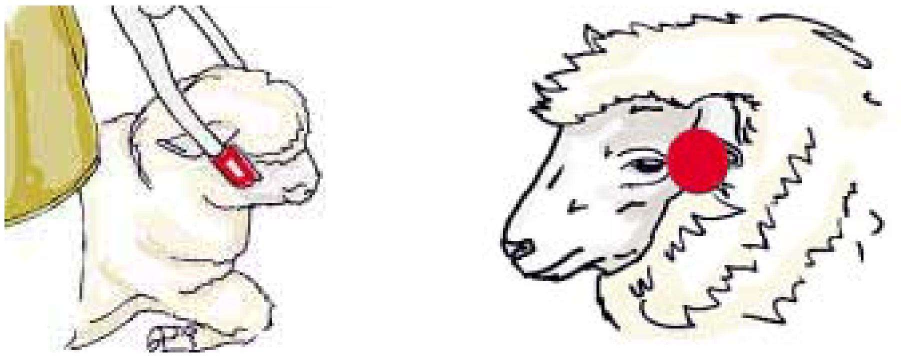

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FIGURE 7.5 **Penetrating CBG with hand trigger**

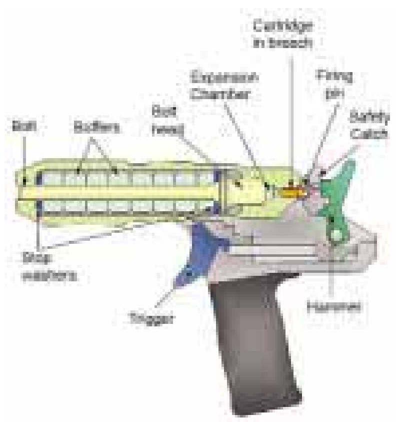

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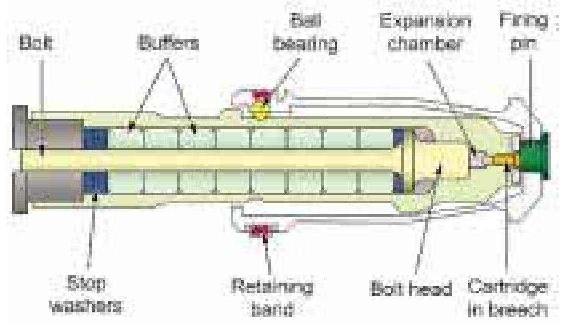
FIGURE 7.6 **Penetrating CBG with contact trigger**



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[CBGs]) can be divided into two broad categories:

- penetrating;
- non-penetrating.

Penetrating CBGs (Figures 7.5 and 7.6) are primarily used for stunning cattle; however, they can also be used for sheep, goats, pigs, deer, horses and rabbits.

There are various non-penetrating devices, ranging from the sledge-hammer or maul to a mushroom-headed CBG (knocker). The knocker (Figure 7.7) is the only non-penetrating device that should be used in practice as, unlike the manual methods, it is designed to apply a controlled blow to the head of the animal. Non-penetrating CBGs should only be used for cattle.

Physical and physiological effects of mechanical stunning

When a penetrating device is used there are two main types of effect. There are the general effects of concussion produced when the bolt impacts with the skull and the physical damage produced when the bolt enters the brain. The impact of the bolt on the skull causes disruption of brain activity resulting in unconsciousness. A common misconception is that the bolt must enter the brain to cause unconsciousness. This is not true and there are devices available that are designed to apply a blow to the head of the animal, inducing concussion, without penetrating the brain. Concussion is normally defined as the reversible loss of consciousness, which is why mechanical stunning should always be followed by a killing method, e.g. exsanguination. However, it must be stressed that concussion is not always a reversible condition and the loss of consciousness may often be long-lasting or even permanent.

The two key elements of mechanical stunning that are required for the effective induction of concussion are the positioning of the blow (shot position) and the amount of energy transferred to the animal's brain (force of impact). Bolt velocity and bolt mass are important because they determine the force of impact of the bolt on the head of the animal and the amount of energy transferred to the brain (kinetic energy). High bolt velocities result in a greater acceleration of the head of the bolt during the percussive blow, which more effectively induces a state of concussion.

Kinetic energy = $1/2\ mv^2$

where m = mass of the bolt, v = bolt velocity

Bolt velocity can be affected by of number of other factors, including:

- gun type and condition;
- choice of cartridge/air pressure.

Shooting positions

A critical factor for successful mechanical stunning is the application of the blow to an area of the head where it will have maximum effect in causing brain dysfunction. In most animals this is the frontal area of the head; however, the ideal position is affected by species, animal age and type of device used (whether penetrating or non-penetrating).

- Cattle: For penetrating devices, the ideal shooting position is the intersection of two imaginary lines drawn between the eyes and the centre of the base of the opposite horn bud (Figure 7.8). A non-penetrating device should be positioned approximately 20 mm above the position used for the penetrating instrument.
- Sheep: For horned animals the captive bolt device should be positioned on the midline, behind the ridge between the horns and aimed towards the base of the tongue (poll position). When animals are shot in the poll position they must be bled within 15 seconds. For polled sheep, the device should be placed on the highest point of the head and aimed vertically (Figure 7.9).
- Goats: The correct position for stunning goats (both horned and polled) is the same as for horned sheep. The captive bolt device should be positioned on the midline, behind the

FIGURE 7.7 **Non-penetrating CBG with hand trigger (knocker)**

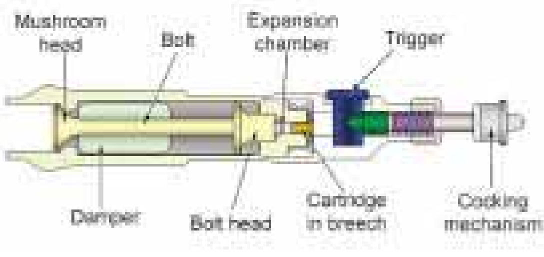

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FIGURE 7.8 **Captive bolt stunning of cattle - gun aimed at right angles to head**

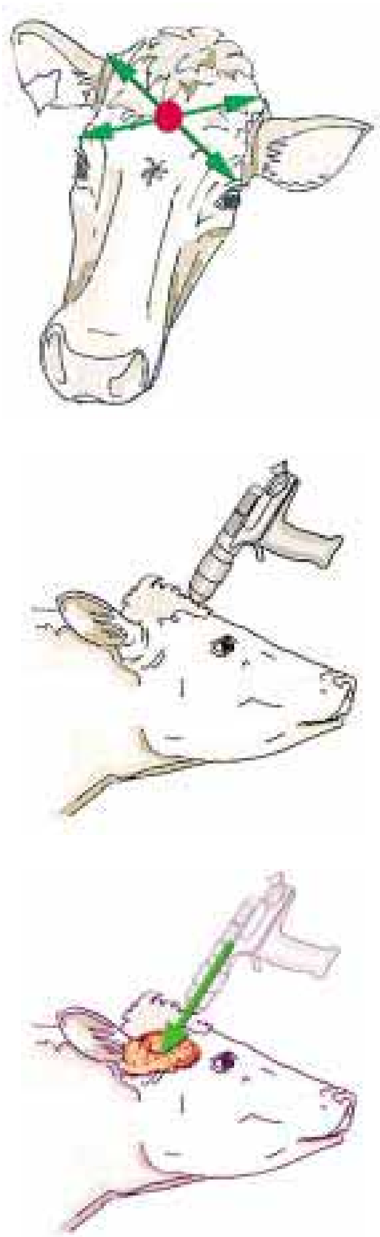

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FIGURE 7.9 **Captive bolt stunning of sheep**

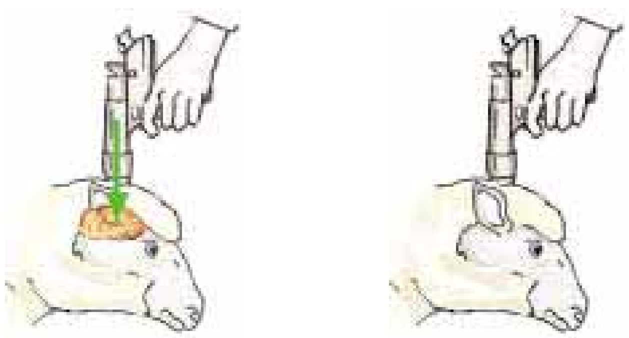

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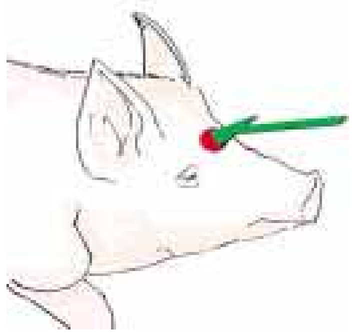
FIGURE 7.10 **Optimum shooting position for pigs**



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ridge between the horns and aimed towards the base of the tongue (poll position).

- Pigs: The device should be placed on the midline, 20 mm above eye level and aimed towards the tail of the animal (Figure 7.10). The position should be 50 mm above eye level for older sows and boars and adjusted slightly off the midline to avoid a bony ridge. Note that CBG stunning can cause severe convulsions in pigs.

Design and operation of captive bolt devices

Captive bolt devices are activated either by trigger or by impact with the animal's head. Non-penetrative devices are always trigger-fired. The choice of device is usually based on species of animal, handling/restraint system, availability, personal preference and experience. The bolt in a captive bolt or concussion device is propelled forward by compressed air or the expansion of an explosive charge held in a blank cartridge. Cartridge strength is expressed in terms of grain size, where 1 grain is the equivalent of 0.0648 g of propellant. It is essential that the cartridges used are appropriate for the type of device and the animal being stunned (Table 7.2).

With captive bolt devices used in the correct shooting position, the bolt penetrates the cortex and midbrain areas (Figures 7.8 and 7.9) where the physical damage can prevent recovery. Following penetration (about 7.5 cm), the bolt is returned back into the barrel by the action of the recuperating sleeves (buffers).

The following are signs of an effective mechanical stun:

- the animal collapses immediately;
- the eyes are fixed;
- no corneal reflex;
- no rhythmic breathing.

TABLE 7.2 **Cartridge sizes based on manufacturer's recommendations**

Animal size & species	Device type	Calibre	Cartridge grain
Very large *(heavy bulls)*	Penetrating Penetrating Non-penetrating	.22 .25 .25	4.0- 4.5 4.0 6.0
Large *(large cattle, horses)*	Penetrating Non-penetrating	.22 .25	3.0- 4.0 5.0
Medium *(other cattle, pigs, goats)*	Penetrating Non-penetrating	.22 .25	2.5 4.0
Small *(sheep, calves, young lambs and goats)*	Penetrating	.22	1.25

The following are signs of an ineffective mechanical stun:

- the animal does not collapse immediately and may attempt to raise its head and stand up;
- the eyes are rolled down;
- positive corneal reflex;
- rhythmic breathing is present.

In the event of an animal being ineffectively stunned or showing signs of recovery, there should be procedures in place to deal with it effectively and protect its welfare. Cattle that are ineffectively stunned or showing signs of recovery should be restunned using a shooting position that is 10 mm above the ideal and 5 mm either to the left or right of the midline. Animals must never be reshot through the first shooting hole.

Slaughter methods following captive bolt stunning

Bleeding either by neck-cutting or by a thoracic stick should be carried out as soon as possible to prevent the risk of recovery. After the use of a penetrating captive bolt device, the animal should be stuck as soon as possible (ideally within 60 seconds). If a non-penetrating device is used, it is even more critical to ensure that sticking is performed as soon as possible.

Additional requirements for mechanical stunning

- Manufacturer's recommendations/instructions must be observed at all times.
- Animals must be appropriately restrained.
- Stunning devices must be well maintained and suitable for species.
- Stunning devices need to be cleaned at the end of production and worn out components must be replaced by parts supplied by the manufacturer. The lumen of the barrel must be brushed out to remove carbon deposits. The undercut (wider area where the bolt head fits) should also be cleaned with a special device called a reaming tool.
- Stunning devices also need to be serviced every two years by the manufacturer.
- A spare stunning device must be available for use in the case of failure or emergency.
- There must be documented procedures for action to be taken in the event of ineffective stunning or an animal showing signs of recovery.
- The animal must be assessed for signs of an effective stun prior to shackling and hoisting and during bleeding.

KILLING

Modified atmosphere stunning/killing

The gas or gas mixtures used to induce unconsciousness must not cause aversion and the duration of exposure must be long enough to cause the death of the animal. This must be verified before any other process is carried out.

The concentration of the gas or gas mixtures used must be continuously monitored and audible and visual warnings given should the gas fall below the correct concentration. The equipment used must be constructed so as to avoid injury to any animal.

How to recognize effective gas killing:

- When the animal leaves the gas chamber it should be off its feet, generally relaxed and must not display rhythmic breathing.
- The animal must not respond to a painful stimulation, e.g. a pinprick to the nose.

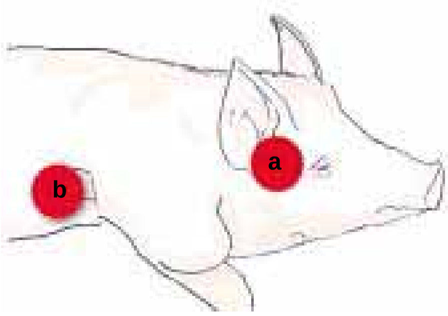
Electrically induced stunning/killing

The application of sufficient current at low frequency (50/60 Hz) to cardiac muscle will result in ventricular fibrillation with subsequent cardiac arrest. Electrical stunning systems can be applied to animals so that the electrodes span both the brain and the heart (Figure 7.11). With sheep, head-to-back systems must apply ≥1.0 amps using electrodes that are applied in front of the brain (in line with the eyes) and in the middle of the animal's back (Figure 7.12). One problem with head-to-back stunning of sheep is pelt-burn caused by the rear electrode. With pigs, automatic systems are designed to apply a split stun system with an initial head-only application (220 volts) and a simultaneous head-to-chest application (120 volts) that commences after the initiation of the head-only stun.

The electrical stun/killing of adult cattle must be carried out in a stunning pen designed for that purpose (Figures 7.13 and 7.14).

Voltages in excess of 260 volts should be applied via electrodes that are capable of delivering ≥1.2 amps to the head and ≥1.6 amps to the heart. There can be some variation in the physical activity seen following cardiac arrest stunning in cattle; for example, the return of

FIGURE 7.11 **Good practice: head-to-back stunning**



Note: head stunning (a) followed by chest electrode (b).

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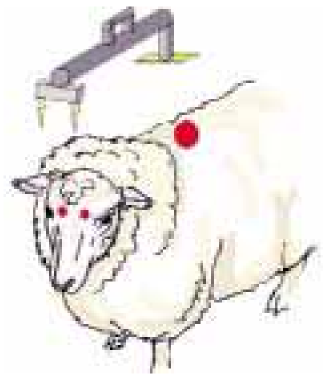
FIGURE 7.12 **Good practice: optimum electrode position for head-to-back electrical stunning of sheep**



Note: the rear electrode is used to stop the heart.

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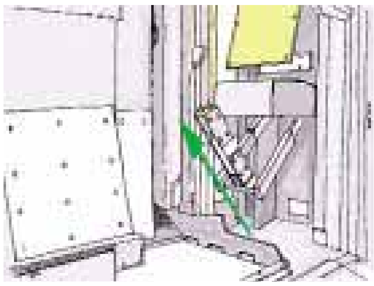
FIGURE 7.13 **Good practice: side view of an electrical stunning pen for cattle with electrodes in the on position**



Note: the arrow shows the direction of the brisket (heart) electrode. Stunning electrodes are in yellow.

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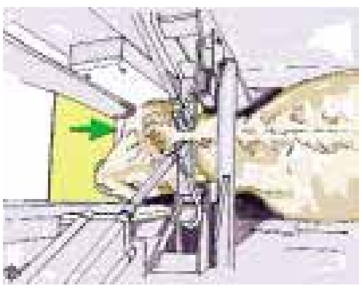
FIGURE 7.14 **Good practice: top view of an electrical stunning pen**



Note: stunning electrodes are in yellow.

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rhythmic breathing has been witnessed in animals that are dying from a cardiac arrest.

Signs of effective electrically induced stunning/killing:

- Tonic phase (usually foreshortened):
  - animal collapses and becomes rigid;
  - no rhythmic breathing;
  - forelegs extended and hindlegs flexed into the body.
- Clonic phase (usually foreshortened):
  - little physical activity.

SLAUGHTER

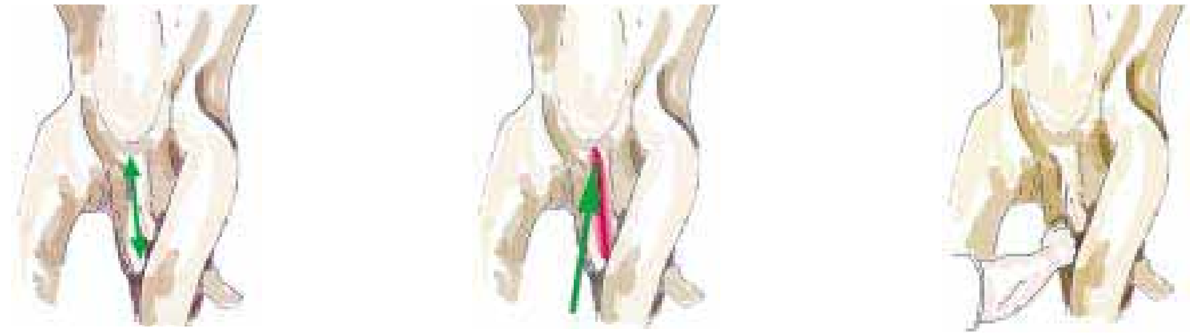
Sticking must only be carried out on animals that are stunned. The knife that is used must be clean and sharp and of sufficient length for the species and size of the animal. Both carotid arteries, or the vessels from which they arise (close to the heart), should be severed.

Following sticking, the animal must be allowed to bleed to death before any further dressing procedure or any electrical stimulation is carried out. The minimum times are 25 seconds after sticking pigs, sheep and goats; and 60 seconds for cattle and deer.

Sticking methods:

- **Thoracic stick:** (a) Make a cut in the jugular crease at the base of the animal's neck.
  (b) With the knife-point at the base of the breastbone and pointed towards the chest, insert the knife to sever the major blood vessels coming from the heart (Figures 7.15 and 7.18).

FIGURE 7.15 **Chest sticking in cattle**



a) Long initial skin cut

b) Sticking point under the sternum

c) Knife inserted into chest in upward direction

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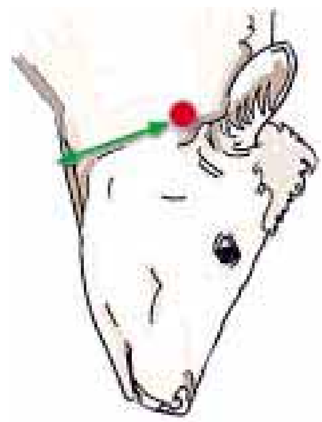
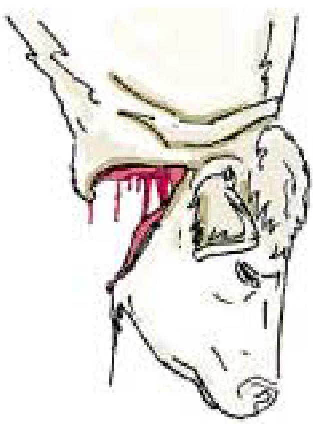
Note: GOOD PRACTICE: for a good bleed out, the popular method is chest sticking, which involves cutting the skin longitudinally from the neck down to the chest following the midline and then cutting into the chest near the heart.

FIGURE 7.16 **Neck sticking in cattle**



a) Position of knife insertion and neck cut in cattle



b) All vessels are severed

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Note: transverse neck sticking can also be used, which must include severance of both carotid arteries and jugular veins.

- **Neck stick:** (c) Insert a knife, close to the head, cut through the neck (with the back of the knife against the spine), cut forward severing all the soft tissues between the spine and the front of the neck. Reverse the blade and cut back against the spine. This action will sever both carotid arteries and both jugular veins (Figures 7.16 and 7.17)

These methods can be used for different animals as follows:

- cattle and calves: (a) + (b);
- pigs: (b);
- sheep and goats: (b) or (c).

Unconventional local/traditional slaughter methods

In some countries unconventional, local slaughter techniques exist. Some of these need consideration:

- immersion of pigs in a basket in water to drown and kill;
- unilateral sticking of pigs in standing position or slaughter on the floor without stunning;
- punctilla of cattle, which involves severance of the spinal cord in the neck without stunning.

The above practices severely compromise animal welfare and must be avoided.

Control of processes

To ensure that the welfare of animals is maintained during slaughter, and that the process operates at maximum effectiveness, a quality management programme should be implemented and maintained. A HACCP-type system is strongly recommended. By making regular measurements at critical control points (CCPs), various critical operations that are carried out by workers handling and slaughtering livestock can be monitored to ensure that they are done correctly, leading to steady improvements in welfare and operational quality. An objective scoring system with five major CCPs of animal handling and slaughter is suggested in Table 7.3. Monitoring and evaluation of the CCPs should be done on a regular basis.

RELIGIOUS SLAUGHTER

Jewish method of slaughter (*shechita*)

Jews consume beef, lamb and poultry, but not pork. These meats must be slaughtered and prepared in accordance with the rabbinical laws. Slaughter is carried out by an approved slaughterman of the Jewish faith, called a *shocet*. The slaughter process, which precludes any type of stunning, is preceded by positioning the animal, though this is not subject to regulation by the religious authorities.

A single, transverse cut severing all tissues and blood vessels is made across the neck using a very sharp, special knife (*chalaf*). The knife has to be examined for its sharpness between each cut. It is usually 16 inches (40.64 cm) long for cattle. Once an animal is dead, an incision is made through the abdominal wall and a Jewish inspector feels at arm's length into the thorax to check for pleural adhesions or any other signs of abnormality. If any abnormality is found, the entire carcass is rejected for Jewish consumption on the grounds that the animal was not healthy at the time of slaughter.

In some practices the meat is porged to remove veins and other forbidden tissues.

FIGURE 7.17 **Neck sticking in sheep**

a) Position of knife insertion and neck cut in sheep

b) Insertion of knife before severance of vessels

c) Exsanguination after neck cut

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FIGURE 7.18 **Chest sticking in pigs**

a) Position of knife insertion and chest cut in pigs

b) All vessels are severed

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TABLE 7.3 **Suggested CCPs for animal handling and slaughter**

CCP	Description of CCP	Method of scoring	Rating of scores
Stunning efficacy	The percentage of animals rendered insensible at the first attempt.	• Captive bolt stunning: a minimum of 20 animals, or 20% in large plants, should be scored per day. • Electrical stunning: score all pigs, sheep or ostriches or a minimum of 100 in a large plant.	• Excellent: 99-100% instantly rendered insensible with one shot • Acceptable: 95-98% • Not acceptable: 90-94% • Serious problems: less than 90% • Excellent: 99.5-100% • Acceptable: 99-99.4% • Not acceptable: 95-98% • Serious problems: less than 95% **NB** If one-shot efficacy falls below 95%, immediate action must be taken to improve the percentage.
Insensibility after stunning	The percentage of animals that remain insensible before and after bleeding.	• Score a minimum of 20 animals or 20% in a large plant. • Evaluate after hoisting for animals that are hoisted after stunning. • Wait 15-30 seconds before evaluating animals that are left on the ground after stunning.	• Excellent: less than 0.1% in cattle; less than 0.05% in pigs • Acceptable: less than 0.2% in cattle; less than 0.1% in pigs **NB** Any animal that shows signs of sensibility must be restunned immediately.
Vocalization	The percentage of cattle that bellow or moo, or pigs that squeal during adverse events, such as a missed stun, excessive electric prod use, excessive pressure from restraint devices, slipping or falling, etc. **NB** Vocalizing score is not used for sheep because they rarely do so.	Each animal is scored for vocalization during handling and stunning, not while in the holding pens. • In crowd pen, lead-up race, stun box or restraint device, score each animal as "Yes" for vocalizer and "No" for non-vocalizer.	Cattle: • Excellent: ≤0.05% = "Yes" • Acceptable: ≤3% = "Yes" • Not acceptable: 4-10% = "Yes" • Serious problem: >10% = "Yes" Pigs: • Excellent: 0% = "Yes" • Acceptable: ≤1% = "Yes" • Not acceptable: ≥2% = "Yes" • Serious problem: ≥10% = "Yes"
Slipping and falling	The percentage of animals that slip and fall during handling or stunning. Selected stations should be chosen for monitoring.	Slipping and falling in the stunning area (includes restrainer entrances, races, holding pens and unloading ramps). • Score a minimum of 20 animals or 10% in large plants. • Score "Yes" for slipping and "No" for no slipping.	• Excellent: no slipping or falling • Acceptable: <3% slipping • Not acceptable: 1% falling down (body touches floor) • Serious problem: 5% falling down or 15% slipping
Electric prodding efficacy	Percentage of animals requiring prodding with an electric goad.	If the prod causes the animal to vocalize, the current is too strong. • Score a minimum of 20 animals or 10% in large plants. • Score "Yes" if animal vocalizes and "No" if it does not.	Total % of cattle prodded: • Excellent: ≤5% = "Yes" • Acceptable: ≤10% = "Yes" • Not acceptable: ≤20% = "Yes" • Serious problem: ≥ 50% = "Yes" Total % of pigs prodded: • Excellent: ≤10% = "Yes" • Acceptable: ≤15% = "Yes" • Not acceptable: ≤25% = "Yes" • Serious problem: ≥ 50% = "Yes"

Special consideration must be given to minimizing welfare problems during *shechita*. Preslaughter handling must have the same criteria used before application of stunning methods. It would be advisable to use a restraint apparatus, preferably an upright stunning pen or one that incorporates a monorail conveyor for Jewish slaughter (Photos 7.2 to 7.4). If necessary, a V-type restraint pen or a Facomia pen (Photo 7.5) that slightly tilts the animal (around 45) can also be used. However, rotating pens that invert the animal 180 and cause undue stress must be avoided. Restraint of animals must be quick, of short duration, and slaughter carried out immediately without delay.

Exsanguination must be carried out rapidly and all blood vessels in the neck cut. The neck needs to be in an extended position during the cut. Ballooning on the cut surfaces of the carotid arteries must be avoided.

Exsanguinated blood must flow rapidly and copiously so that brain death is quick. Physical restrictions in the neck area impeding blood flow must be avoided (e.g. metal parts of the restraint device).

At least 20 seconds must be allowed for exsanguination before any other procedures. In some practices, Jewish authorities allow captive bolt stunning after the neck cut. Where possible, this should be encouraged to protect animal welfare.

Muslim method of slaughter (*halal* slaughter)

This method is now commonly referred to as *halal* slaughter. As for Jews, pig meat is forbidden. There seems to be more variation in the way slaughter is practised than in the Jewish system. These variations are possibly due to different interpretations of the Koran and the Hadis (the sayings of the prophet Mohammed).

The act of slaughter (*Al-Dhabh*) is allowed in the name of God; therefore pronouncing the name of Allah is the usual practice. Animals are restrained but there are no specific religious regulations as to how this should be done. Following restraint, slaughter is achieved by severing both carotid arteries and jugular veins using a sharp knife. The usual type of incision is severance of the vessels in the retrograde fashion following an initial stab incision in the neck, as described above under Slaughter . A sharp slaughter knife is sufficient. The most significant variation in *halal* slaughter is that preslaughter stunning may be an acceptable practice. It is now more common to see stunning being used for *halal* slaughter in western countries. Furthermore, all *halal* meat produced in New Zealand for export to Asia and the Near East comes from animals killed after electrical stunning. However, the stunning method must not kill the animal before exsanguination. Therefore, head-only electrical stunning (so that the current does not reach and stop the heart) or captive bolt stunning may be used if acceptable.

Animal welfare concerns in religious slaughter

Religious slaughter has been a controversial issue for decades because of concerns about animal welfare. These can be summarized as follows:

- stressful preslaughter handling:
  – rotating pens, tying of legs and blindfolding of animals;
- possibility of pain during neck cut and afterwards:
  – neck cuts on conscious animals, wound edges rubbing together, ballooning on carotid arteries;
- variations in the time to loss of unconsciousness after exsanguination:
  – ineffective cuts and ballooning that impede blood loss and compromise welfare.

The following recommendations are made for religious slaughter:

- slaughtermen must be trained and experienced so that animal handling and slaughter are carried out efficiently and effectively;
- tying legs of animals and blindfolding should be avoided;
- the knife must be sharp and the neck cut made swiftly to sever all blood vessels;
- ballooning on cut ends of the carotid arteries should be prevented; if this occurs, it should be investigated and measures taken to prevent it;
- blood loss must be rapid so that consciousness is lost as soon as possible;
- sufficient time must be allowed for exsanguinations;
- a stunning method such as electrical or captive bolt stunning before *halal* slaughter

and immediately after *shechita* should be encouraged;
- operative safety is of particular concern – religious slaughter of only manually shackled animals can be dangerous and accidents may be reduced if a restraint apparatus is used. Sharp knifes can also inflict cuts due to unexpected movement of animals.

Blood loss during religious slaughter

This is an important issue that is often raised when comparing religious slaughter with no stunning with stunning and slaughter. It has frequently been argued that stunning may impede blood loss. Recent research by Bristol University has shown that blood loss is not impeded after stunning compared to slaughter without stunning in sheep (Figure 7.19). Similar results have been found in cattle. This should help allay fears about adverse effects of stunning on blood loss.

STUNNING, SLAUGHTER AND PUBLIC HEALTH CONCERNS/PROTECTION

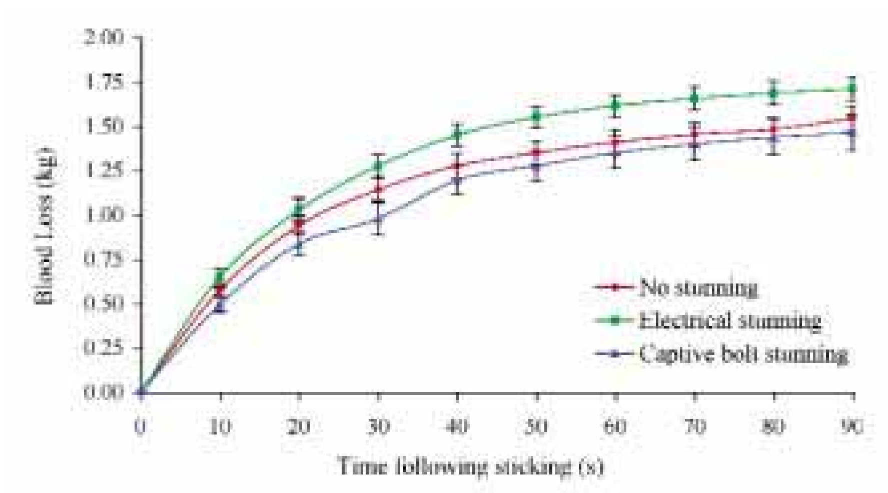
Contamination of carcasses by stunning methods

Since the bovine spongiform encephalopathy (BSE) outbreak, stunning and slaughter procedures have been questioned and considered for the potential risk of contaminating edible parts of the carcass with central nervous system (CNS) material. Research has shown that captive bolt stunning can cause brain tissue to become dislodged and disseminated into the blood circulation in cattle and sheep (Box 7.1). Since, in a BSE-infected animal, brain and spinal cord tissue contain the highest number of infective units, carcasses may be contaminated with the BSE agent. In addition, there is a possibility of contaminating the brain with pathogenic bacteria through the use of captive bolt stunning (Box 7.2). Consequently, there are now concerns and discussions about the use and future of CBGs and alternative stunning methods are being considered. One alternative is the use of electrical stunning. However, this method is expensive, and incorrect use may result in welfare problems. Nevertheless, an automated system of electrical stunning is successfully used in New Zealand.

Contamination of beef carcasses by spinal cord material during splitting

Since 1989, legislation in the United Kingdom has required the removal of the spinal cord from beef carcasses after splitting. A similar requirement was introduced by the European Commission on 1 October 2000, calling for the removal of CNS material from sheep carcasses over 12 months of age and all cattle carcasses in all European Union states. However, in the majority of abattoirs, carcasses are split using a band saw. This often cuts the spinal cord in half

FIGURE 7.19 **Comparison of the effects of different slaughter methods on blood loss in sheep**



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BOX 7.1 **Implications of captive bolt stunning for public health and animal welfare**

The use of captive bolt guns (CBGs) may damage intra-cranial blood vessels and dislodge brain tissue. The heart continues pumping for several minutes following the use of a CBG, during which time any central nervous system (CNS) material that enters the jugular venous blood could be disseminated throughout the body. This possibility and the concern have been investigated in studies conducted in cattle and sheep. Blood samples from Foley catheters, introduced into both jugular veins and inflated after stunning the animals with one of several CBG, were taken for analysis. The stunning methods tested were: pneumatically-activated penetrating CBG (no pithing required due to air injection into spinal canal); cartridge-operated conventional penetrating CBG, known as Cow followed by pithing; non-penetrating cartridge-operated (therefore no pithing) CBG, known as Cash Knocker; electrical stunning (only in sheep).

These projects used immunocytochemistry on sections of buffy-coat cytoblocks for S-100b protein, and capture enzyme-linked immunosorbent assay (ELISA) for syntaxin 1-B to look for CNS tissue in blood. Neither of these CNS proteins is normally found in the blood (Anil *et al.*, 1999, 2001; Anil and Harbour, 2001; Love *et al.*, 2000).

Multiple fragments of brain tissue were detected in the jugular venous blood of cattle slaughtered after use of a pneumatically operated penetrating CBG and after the use of a conventional cartridge-operated CBG followed by pithing. CNS tissue was also detected in the jugular venous blood of sheep that had been stunned with a conventional penetrating CBG or in those stunned with a pneumatically activated penetrating CBG. Electrical stunning did not result in any detectable neural tissue in blood. The emboli are detectable in jugular venous blood within 30 seconds of stunning and will already have passed into and, possibly, through the lungs before exsanguination is carried out. It is noteworthy that the showers of embolic brain tissue include many fragments of small size CNS tissue, which, in principle, are capable of passing through the pulmonary capillary bed. Further studies are planned to detect emboli in arterial blood and visceral organs.

These results confirm that there is a risk of embolic dissemination of brain tissue with the use of the pneumatically operated air injection gun and, in addition, show that neuroembolism can also occur with use of a conventional penetrating CBG followed by pithing in cattle. Penetrative captive bolt devices, if applied correctly, can provide an effective stunning method that needs to be followed by a procedure that results in the death of the animal (Daly, Gregory and Wotton, 1987), for example exsanguination or pithing. Pithing, a common practice in 70 percent of abattoirs in the United Kingdom (Meat Hygiene Service, 1997), has been used by the industry to protect operative safety by greatly reducing the reflex kicking that takes place following captive bolt stunning. It is also commonly claimed that pithing has welfare benefits as it prevents recovery in effectively stunned animals. As a result of the BSE contamination fears, pithing is now banned in the whole of the European Union. However, this new ban has implications for abattoir operators handling carcasses as well as for animal welfare.

When penetrating captive bolt stunning is used, the bolt trajectory causes considerable damage. We have, in a preliminary investigation, examined brains of several cattle stunned with a penetrating captive bolt. We estimate that an average of 10 g of brain tissue (out of a total of 450 g) can be dislodged (unpublished results). On the basis of these criteria, we have calculated that between 50 mg and 500 mg of brain tissue should be sufficient for transmission of infection by the oral route. Therefore, 10 g of dislodged brain tissue may represent between 20 and 20 000 units of infectivity (Anil and Harbour, 2001).

In regard to sheep, although there are no naturally occurring cases, the possible infection of sheep with BSE is a cause for concern. Therefore, the use of electrical stunning seems to be the safer option at present (Anil *et al.*, 2001).

Source: Anil and Austin, 2003.

BOX 7.2 **Contamination by micro-organisms during captive bolt stunning**

To determine whether penetrating captive bolt stunning of animals can result in internal and/or external microbial contamination of meat, slaughter sheep were inoculated with marker organisms (*E. coli* K12 or *Ps. fluorescens*) into the brain through the stun wound immediately after stunning by a cartridge-operated, penetrative captive bolt gun (CBG). The marker organisms were detected in blood, liver, lungs, spleen, lymph nodes, in deep muscle and on carcasses. When the gun that had been used to stun a brain-inoculated animal was used to stun consecutive, intact sheep, the marker organisms were found in blood of 30 percent and on the carcass surface of 40 percent consecutively stunned animals. Overall, the results from this study indicate that penetrative stunning of food animals can carry risks of internal and/or external microbial contamination of edible tissues and organs. Similar results have been obtained using the same markers in cattle (Daly *et al.*, personal communication).

These recent developments summarized above could undoubtedly have implications for public health measures and animal welfare at slaughter. It is clear that there is a risk of contamination of carcasses with CNS tissue if a pneumatically operated CBG or a cartridge-operated CBG followed by pithing is used. The ban on pithing should reduce the risk considerably. However, it is also possible that penetrating CBGs alone could cause problems. The results of recent research on the spread of central nervous tissue resulting from the use of different stunning devices are currently under discussion by the European Commission (EC) and the United States Food and Drug Administration (FDA). This is likely to lead to prohibition of the use of pneumatically operated guns and penetrating CBGs in cattle and sheep. Therefore, there is need to consider the options left and improvements to be made.

First, non-penetrating guns offer a good alternative. However, the potential problems associated with this type of gun should be resolved, such as the infrequent recovery before exsanguination. Second, the removal of pithing is causing operative safety problems in some plants, especially, where space is limited. An alternative solution to this problem is required. Third, electrical stunning should be considered for stunning cattle. This system is used in three plants in the United Kingdom. However, the high cost and some doubts about animal welfare associated with sometimes ineffective use of this method need looking into.

Source: Anil and Austin, 2003.

along much of its length. Obviously this may lead to potential dissemination of CNS material over the carcass and surrounding area, resulting in possible contamination with the BSE infective agent.

Studies conducted by Helps *et al.* (2002) have shown the presence of CNS material on carcasses after splitting with a conventional band saw. This contamination was still present after the carcass had been washed or steam vacuum-cleaned. However, significantly less CNS contamination was observed on carcasses following the removal of the spinal column by an experimental oval saw, which cuts out the whole spinal column and dorsal root ganglia from the carcass prior to splitting. With further engineering development, this new technique should be capable of removing spinal cord with minimal risk of contamination. Hot boning is another alternative method that is being investigated to reduce contamination of the carcass with CNS material.

Summary

- Animals should be stunned before slaughter in order to render them unconscious, and hence insensible to pain during slaughter.
- All stunning methods should:
  - render the animal unconscious immediately and the state of unconsciousness should last until death;
  - be verifiable in their effectiveness;
  - be implemented by trained and competent operatives;
  - be safe for the operatives;
  - be implemented in such a way that they do cause contamination of the meat with any hazards.
- Stunning methods that are currently employed include:
  - electrical stunning, which may be applied to the head only or to the head and body; the latter causes cardiac arrest, and hence kills the animals;
  - modified atmosphere stunning, which involves the use of high concentration of gases such as carbon dioxide, nitrogen or argon; the method may also be employed as a killing method;
  - captive bolt stunning; the method may be either concussive only or concussive and penetrative – the animal does not usually recover in the latter case. For each species:
    - the correct gun calibre and cartridge strength should be used;
    - the appropriate shooting position should be used;
    - guns should be maintained in good working condition and stored safely when not in use.
- Animals should be exsanguinated as soon as possible after stunning, especially if the stunning methods allow the animals to recover.
- Sticking should be done with a clean knife that does not cause contamination of the meat.
- Thoracic sticking is recommended over neck sticking.
- Religious slaughter that does not include stunning should be carried out efficiently and effectively, with consideration for the animal's and operative's welfare, as well as meat safety.
- In the light of the threat of transmissible spongiform encephalopathies (TSEs), there are ongoing investigations for ways of averting possible contamination of the carcasses with CNS material during stunning, slaughter and carcass cutting.

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SECTION 8

Post-mortem inspection

Post-mortem inspection systems should include:

- procedures and tests that are risk-based to the extent possible and practicable;
- confirmation of proper stunning and bleeding;
- availability of inspection as soon as is practicable after completion of dressing;
- visual inspection of the carcass and other relevant parts, including inedible parts, as determined by the competent authority;
- palpation and/or incision of the carcass and other relevant parts, including inedible parts, as determined by the competent authority according to a risk-based approach;
- additional palpation and/or incisions, as necessary to reach a judgement for an individual carcass and other relevant parts, and under appropriate hygiene control;
- more detailed inspection of edible parts intended for human consumption compared with inspection of those parts for indicator purposes alone, as appropriate to the circumstances;
- systematic, multiple incisions of lymph nodes where incision is necessary;
- other organoleptic inspection procedures, e.g. smell, touch;
- where necessary, laboratory diagnostic and other tests carried out by the competent authority or by the establishment operator under instruction;
- performance criteria for the outcomes of organoleptic inspection;
- regulatory authority to slow or halt processing so as to allow adequate post-mortem inspection at all times;
- removal of specified parts if required by the competent authority, e.g. " specified risk materials" for BSE; and
- proper use and secure storage of equipment for health marking.

Source: FAO/WHO. 2004. Draft code of hygienic practice for meat. In *Report of the 10th Session of the Codex Committee on Meat Hygiene.* Alinorm 04/27/16. Rome (available at ftp://ftp.fao.org/codex/Alinorm04/AL04_16e.pdf).

MEATCOPHOTOS

Diseases covered in this section

GENERAL PATHOLOGICAL CONDITIONS

SPECIFIC DISEASES

DISEASES CAUSED BY VIRUSES

DISEASE CAUSED BY PRIONS

DISEASES CAUSED BY *RICKETTSIA* AND *MYCOPLASMA* SPP.

DISEASES CAUSED BY BACTERIA

PARASITIC DISEASES

Diseases caused by helminths

Diseases caused by protozoa

Diseases caused by arthropod parasites

INTRODUCTION

Post-mortem inspection of carcasses is part of the wider process of screening animals and meat for fitness for human consumption, a process that includes on-farm monitoring, ante-mortem inspection and HACCP implementation in abattoirs.

Lately, there has been a widespread recognition that traditional meat inspection protocols, involving detailed inspection of tissues, particularly lymph nodes, through multiple incision and palpation, are not necessarily universally appropriate and they may in fact introduce or spread contamination. In parts of the world where particular zoonotic diseases that produce gross pathological manifestations have been eradicated or are controlled to the point where occurrence is a rare event, the major hazard in meat is microbiological (*Escherichia coli* in beef; *Salmonella* in beef and pork; *Yersinia* in pork) and traditional inspection methods will not detect this. For these microbiological hazards, a risk-based approach to post-mortem meat inspection may be deemed more appropriate.

However, in areas where diseases such as tuberculosis or erysipelas and parasitic infestations such as *Cysticercus bovis* and fascioliasis are prevalent, incision and palpation are the best means of revealing the disease. In other words, the general rule is that the type of inspection must reflect local disease risk.

Further changes to the inspection process for cattle and sheep have been required since the recognition of a risk to human health posed by transmissible spongiform encephalopathies (TSEs), primarily bovine spongiform encephalopathy (BSE). It is now imperative to remove from the edible carcass known tissues or organs that carry the highest risk of infectivity in a BSE-infected animal and to check that their removal has been complete. In addition, the means of reducing the risk of carcass contamination by brain and spinal cord (the highest risk organs), arising during slaughter and dressing procedures, are being identified as research investigations proceed. Unfortunately, TSEs do not manifest as gross pathological lesions, and cannot be detected on post-mortem meat inspection alone. The risk is minimized by removing suspect animals at ante-mortem inspection, and by removing the high-risk tissues.

The aims of post-mortem inspection are to ensure that the meat produced is wholesome, disease-free, and will pose no risk to human health. The decision as to whether meat is fit for consumption or not will utilize many skills of observation and evaluation, and should take into consideration the results of ante-mortem inspection, as well as any available information on the disease history of the herd or region of origin of the animals.

GENERAL PRINCIPLES

- Post-mortem inspection should be carried out without delay after dressing of the carcass is complete. Some lesions may fade with time. Conversely, it should be possible to set suspect carcasses aside for re-inspection later, as some lesions will intensify with time.
- Apart from skin (plus sheep's and goat's heads, and the penis from all species, where these organs are not intended for human consumption), no part of the animal should be removed from the premises until post-mortem inspection is completed and any samples required for further testing have been obtained.
- If blood is collected for human consumption, it is subject to inspection and subsequent passing as fit or unfit in the same way as edible meat and offal. Where blood or offal from several animals is collected in the same container, the batch must be rejected if any single animal is unfit. Conversely, if batched blood shows a condition requiring rejection of a carcass, all carcasses donating the batched blood are rejected.
- It is essential that correlation of a carcass with its separated offal be maintained until inspection is finished because the result of inspection of either carcass or offal will have implications for the action required to be taken on the other part. An effective labelling system is thus required for both carcasses and offal.
- Parts that contain lesions (e.g. abscesses, inflamed lymph nodes, cysts), exhibit a condition deemed inappropriate in edible meat, or present evidence of adulteration must be detained and labelled as such, until further inspection is completed.

- Parts found to be unfit for human consumption must be labelled as such.
- Clear marking of carcasses passed as fit for human consumption must follow immediately after the completion of inspection. The mark must be clearly visible and unambiguous (e.g. in the European Union [EU] the health mark); unfit carcasses are not marked in this way. Where TSE testing is undertaken, the health mark must not be applied until the test result is known.
- Some localized conditions (abscess, arthritis, bruising, contamination) may require partial rejection of a carcass or organ, with only the affected part and tissue in the immediate vicinity being separated and classed as unfit.
- Many conditions exhibit a range of severity ranging from localized to general, acute to chronic, and there is a corresponding range of measures that apply to address the health risk. For example, arthritis can be mild with little damage to the cartilaginous surfaces, non-septic and limited to one joint, which can then be passed as fit for consumption. Or, passing through many intermediate stages, it can be severe and septic, with abscesses around several joints and thus requiring rejection of the whole carcass. Decisions on rejection have to be made on a case-by-case basis, after assessing the significance of the findings.

Post-mortem inspection should provide necessary information for the scientific evaluation of pathological lesions pertinent to the wholesomeness of meat.

Professional and technical knowledge must be fully utilized in:

- viewing, incision, palpation and olfaction techniques;
- classifying lesions into one of two major categories – acute or chronic;
- establishing whether the condition is localized or generalized, and the extent of systemic changes in other organs or tissues;
- determining the significance of primary and systemic pathological lesions and their relevance to major organs and systems, particularly the liver, kidneys, heart, spleen and lymphatic system;
- coordinating all the components of ante-mortem and post-mortem findings to make a final diagnosis;
- submitting the samples to the laboratory for diagnostic support, if the abattoir has holding and refrigeration facilities for carcasses under detention.

TRADITIONAL INSPECTION PROCEDURES AND ASSESSMENTS

Post-mortem inspection will utilize many body senses, including sight, smell and touch. Incision into organs and lymph nodes will allow more detailed inspection of these parts. First, a general visual inspection of the carcass, offal and, where appropriate, blood, should be made to detect bruising, oedema, arthritis, condition of peritoneum and pleura and any swelling or abnormality. Other procedures are species- and/or age-determined.

Bovines six weeks old or older

- **Head.** Detailed examination of lymph nodes by incision is needed, the nodes being the submaxillary, retropharyngeal and parotid. The cheek muscles are inspected using deep incisions: two parallel incisions are made in the masseter muscle and a single longitudinal incision in the pterygoid muscle. The mouth and tongue are visually inspected and the tongue is also palpated.
- **Lungs and trachea.** If the lungs are intended for human consumption, incision is additional to visual and palpation inspection required for lungs generally. The trachea and bronchi are opened by knife and the lower ends of the suspended lungs are incised. The bronchial and mediastinal lymph nodes are incised.
- **Heart and pericardium.** Following visual examination of the heart and pericardium, the former is incised down its long axis, cutting through the interventricular septum to expose the ventricular chambers.
- **Liver.** A combination of visual and palpation inspection procedures to include the hepatic and pancreatic lymph nodes. Incision of the caudate lobe of the liver is also required to expose the bile ducts. The presence of fascioliasis lesions should also be checked.
- **Alimentary tract.** Visual inspection of the tract and mesentery accompanied by palpation of the gastric and mesenteric lymph nodes and incision if deemed necessary.
- **Spleen.** Visual/palpation.

- **Kidneys.** Visual and detailed examination of renal lymph nodes if necessary.
- **Diaphragm.** Visual inspection.
- **Genital organs.** Visual inspection.
- **Udder.** If intended for human consumption, each half is incised by a deep cut extending to the lactiferous sinuses and the lymph nodes are incised. Otherwise, visual inspection and examination of the lymph nodes through palpation.

Bovines less than six weeks old

- As for older cattle, except for the following inspections, which are not necessary:
  - **head**: submaxillary and parotid lymph nodes, masseter muscle;
  - **liver**: bile ducts and pancreatic lymph nodes.
- Additional items are:
  - **umbilicus**: visual inspection, and palpation, incision if deemed necessary;
  - **joints**: visual and palpation, incision to examine synovial fluid if deemed necessary.

Pigs

- Similar to adult cattle, except for the following inspections, which are not necessary:
  - **head**: only the submaxillary lymph node is inspected;
  - **liver**: no bile duct incision;
  - **udder**: visual inspection and incision of supramammary lymph nodes in sows.
- As in young cattle, the **umbilicus** and **joints** of young pigs are inspected visually and by palpation and, if thought necessary, by incision.

Sheep and goats

- Inspection of small ruminants is less detailed than for cattle and pigs. The following procedures are generally required:
  - **head**: if destined for human consumption, the throat, mouth, tongue, retropharyngeal and parotid lymph nodes are examined;
  - **lungs**: examine for parasites, particularly nematode worms and hydatid cysts;
  - **carcass**: palpate to detect inoculation abscesses;
  - **heart**: incise lengthways;
  - **umbilicus**: (young animals) visual inspection and incision where necessary;
  - **joints**: (young animals) visual inspection and incision where necessary.

RISK-BASED INSPECTION PROCEDURES

In certain circumstances, the competent authority may allow the use of a risk-based system of inspection instead of the traditional inspection procedures outlined above. In traditional systems, each individual animal is fully inspected, whereas a risk-based system may allow random full inspection of a proportion of the animals presented for slaughter. For a risk-based system to ensure wholesomeness of meat, the animals presented must be uniform, slaughter-generation (i.e. young) animals, of known health status. Older, cull animals would not be acceptable in such a system, as they carry a high risk of carrying diseases and pathogens.

To fulfil the requirement of known health status, an integrated rearing system would be needed, so that the disease history and management details of the herd/flock are known to the official carrying out meat inspection, including results of previous post-mortem inspections. From this information, the official would be able to make a judgement on the risk posed by the animals presented, and modify the post-mortem inspection regime accordingly. Therefore, if the risk were microbiological only, minimizing cross-contamination and preventing faecal contamination would be the priority, so the inspection would be predominantly visual. However, if the risks were pathological, there would be a case for returning to traditional meat inspection procedures to allow removal of high-risk tissues and carcasses.

CARCASS JUDGEMENT

Trimming or condemnation may involve:

- any portion of a carcass or a carcass that is abnormal or diseased;
- any portion of a carcass or a carcass affected with a condition that may present a hazard to human health;
- any portion of a carcass or a carcass that may be repulsive to the consumer.

Localized versus generalized conditions

It is important to differentiate between a localized and a generalized condition in the judgement of an animal carcass. In a localized condition, a lesion is restricted by the animal defence mechanisms to a certain area or organ. Systemic changes associated with a localized condition may also occur, e.g. jaundice caused by liver infection or toxaemia following pyometra (abscess in the uterus).

In a generalized condition, the animal's defence mechanisms are unable to stop the spread of the disease process by way of the circulatory or lymphatic systems. The lymph nodes of the carcass should be examined if pathological lesions are generalized.

Some of the signs of a generalized disease are:

- generalized inflammation of lymph nodes, including the lymph nodes of the head, viscera and/or the lymph nodes of the carcass;
- inflammation of joints;
- lesions in different organs including liver, spleen, kidneys and heart;
- the presence of multiple abscesses in different portions of the carcass, including the spine of ruminants.

Generalized lesions usually require more severe judgement than localized lesions.

Acute versus chronic conditions

Acute conditions

An acute condition implies that a lesion has developed over a period of some days, whereas a chronic condition implies the development of

TABLE 8.1. **Post-mortem inspection techniques**

Tissue	**Inspection technique**	**Examples of abnormality**	**Examples of possible causes**	**Judgement**
Lymph nodes	Visual Palpation Incision	Enlargement Haemorrhage Abscess Calcification	Local infection e.g. mastitis, foot abscess Systemic disease e.g. tuberculosis, swine fever	Local infections - examine and trim affected part Systemic disease - reject for human consumption, consider animal health risks
Muscle, including heart, tongue, cheek muscles	Visual Palpation Incision	Bruising Abscess Cyst Pale discoloration Petechial haemorrhages (blood splash)	Trauma Infection Tapeworm Protozoal infestation	Bruises - trim, consider welfare Infections - trim, judge carcass on merits Tapeworm - trim, check for others, if generalized, reject Protozoa - reject
Lungs	Visual Palpation Incision	Pneumonia Abscess Cyst	Infection Tuberculosis Tapeworm	Check for generalized disease and judge carcass accordingly
Liver	Visual Palpation Incision	Abscess Swelling Liver flukes	Infection Systemic illness Fluke infestation	Reject liver, check for signs of systemic disease and judge carcass accordingly
Kidney	Visual Palpation Incision	Cyst Petechial haemorrhages Pus	Hydronephrosis Systemic illness e.g. swine fever, pyelonephritis	Hydronephrosis - check carcass for abnormal odour, judge accordingly, reject kidney Pyelonephritis/ petechiae - check for systemic disease, judge accordingly, consider animal health risks

lesions over a period of some weeks, months or years. A subacute condition refers to a time period between an acute and a chronic condition.

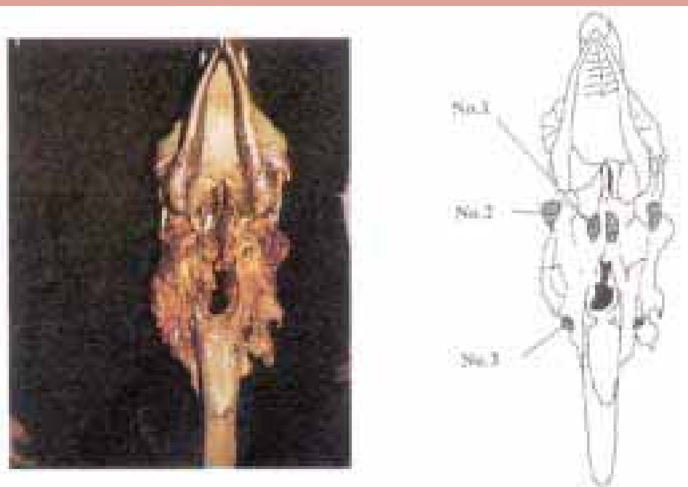
The acute stage is manifested by inflammation of different organs or tissues, enlarged haemorrhagic lymph nodes and often by petechial haemorrhage of the mucosal and serous membranes and different organs, such as heart, kidney and liver. An acute stage parallels with the generalized disease complex, when an acute infection tends to overcome the animal's immune system and becomes generalized.

Each case showing systemic lesions should be assessed individually taking into account the significance that these lesions have for major organ systems, especially the liver, kidneys, heart, spleen and lymphatic system, as well as the general condition of the carcass.

Chronic conditions

In a chronic condition, inflammation associated with congestion is replaced by adhesions, necrotic and fibrotic tissue or abscesses. The judgement in the chronic stage is less severe and frequently the removal of affected portions is required, without the condemnation of the carcass. However, judgement on the animal or carcass tends to be more complicated in subchronic and sometimes in peracute stages. If generalized necrotic tissue is associated with previous infection, the carcass must be condemned.

FIGURE 8.1 **Head inspection**



Retropharyngeal (1), parotid (2) and submaxillary (3) lymph nodes are viewed and incised by multiple incisions and slicing

Source: D. Herenda, Canada.

GUIDELINES FOR MINIMUM POST-MORTEM INSPECTION REQUIREMENTS[1]

Heads

General

View external surfaces. For cattle, horses, pigs and game view the oral and nasal cavities.

Lymph nodes (Figure 8.1)

Submaxillary, parotid and retropharyngeal: view and incise.[2]

Tongue

View and palpate.[3] View only in calves up to six weeks of age.

Other

Cattle

Except in calves up to six weeks of age, the oesophagus of all cattle and calves should be separated from its attachment to the trachea and viewed. As part of inspection of all cattle and calves over the age of six weeks for *Cysticercus bovis*, the muscles of mastication should be viewed and one or more linear incisions made parallel to the lower jaw into the external and internal muscles of mastication; in addition one incision into *Musculus triceps brachii*, 5 cm behind the elbow, should be made.

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[1] These are guidelines for inspection requirements; the inspection can be made more intensive or less intensive depending on the outcome of the examination.

[2] Incise   means to incise by multiple incisions or slicing.

[3] Palpate   means to view and palpate.

Horses

The head should be split lengthwise in the medial line and the nasal septum removed and examined in all horses that are from areas where glanders is endemic.

Pigs

Where there is a risk of *Cysticercus cellulosae* being present, the outer muscles of mastication, the abdominal and diaphragmatic muscles and the root of the tongue of all pigs should be incised and the blade of the tongue viewed and palpated.

Game

Inspection cuts for tapeworm cysts are not necessary, as these cysts are generally not infective for humans.

Viscera

Lungs (Figure 8.2 and Photo 8.1)

View and palpate. Except in sheep and goats, the bronchi should be opened up by a transverse incision across the diaphragmatic lobes. For horses and cattle, the larynx, trachea and main bronchi should be opened along their length.
Lymph nodes. Bronchial (tracheobronchial) and mediastinal: incise. View only in calves up to six weeks of age.

Heart (Photo 8.2)

View after the removal of the pericardium.

Cattle

The heart of all cattle and calves over the age of six weeks should be inspected for *Cysticercus bovis* either by making one or more incisions from base to apex or by everting the heart and making shallow incisions that enable the cardiac valves and muscle tissue to be inspected; this inspection of the heart should also be undertaken in calves up to six weeks of age that are from areas where *C. bovis* is endemic.

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PHOTO 8.1
Lung inspection in buffalo: open trachea and incised bronchial and mediastinal lymph nodes

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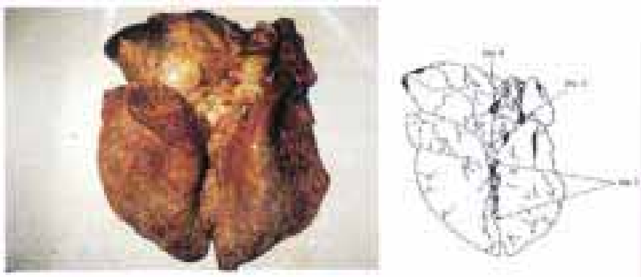
PHOTO 8.2
Heart inspection: lengthwise incisions (minimum four) from base to apex into the heart muscles; observe cut surfaces

FIGURE 8.2 **Lung inspection**



Bronchial left (1) and right (2) and mediastinal (3) lymph nodes are viewed and incised
Source: D. Herenda, Canada.

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PHOTO 8.3
Stomach and spleen inspection: viewing of rumen and viewing and palpation of spleen

PHOTO 8.4
Viewing of rumen, reticulum, omasum and abomasum

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Pigs
The heart of all pigs derived from areas where there is a risk of *C. cellulosae* being present should be opened up and the deep incision made into the septum.

Liver (Figure 8.3)
View and palpate entire surface (both sides). View the gall bladder. For cattle over six weeks of age, incise as deemed appropriate to detect liver flukes. Open large bile ducts. For sheep, pigs and game, incise as deemed appropriate for parasites.
Lymph nodes. Portal (hepatic), view and incise.

Spleen (Photo 8.3)
Palpate.

Gastro-intestinal tract (Photos 8.4 and 8.5)
View (only, in calves up to six weeks of age). Mesenteric lymph nodes, view only in calves up to six weeks of age. View and incise if any lesions were observed in the submaxillary lymph nodes.

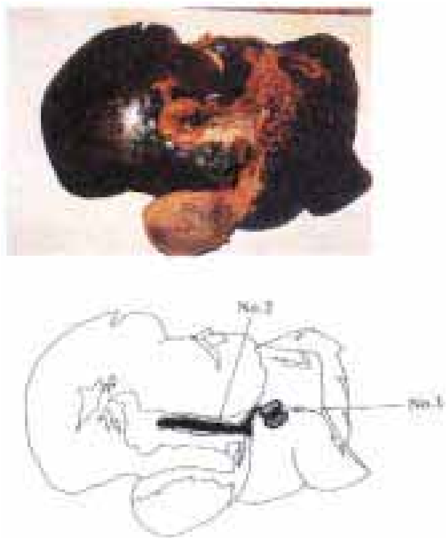
Kidneys
View after enucleation. In grey and white horses, incise.

Uterus (adults)
View.

Carcass

General
Examine carcasses (including musculature, exposed bones, joints, tendon sheaths, etc.) to determine any signs of disease or defect. Attention should be paid to bodily condition, efficiency of bleeding, colour, condition of serous membranes (pleura and peritoneum), cleanliness and the presence of any unusual odours.

FIGURE 8.3 **Liver inspection**



Incised portal (hepatic) lymph nodes (1) and opened large bile duct (2)

Source: D. Herenda, Canada.

Lymph nodes
The main carcass lymph nodes – being the precrural, popliteal, anal, superficial inguinal, ischiatic, internal and external iliac, lumbar, renal, sternal, prepectoral, prescapular and atlantal nodes, as well as the lymph nodes of the head and viscera – should be incised and examined in all animals in which systemic or generalized disease is suspected, in all animals positive to a diagnostic test for tuberculosis and in all animals in which lesions suggestive of tuberculosis are found at post-mortem inspection. In all other animals the following examination techniques should be used for specific lymph nodes:

- superficial inguinal (male) (Photo 8.6) – palpate;
- supramammary (female) – palpate and incise when udder is or has been in lactation, or in the case of mastitis;
- external and internal iliac (Photos 8.6 and 8.7) – palpate iliac nodes in pigs;
- prepectoral (Photo 8.8) – palpate;
- popliteal (Photo 8.9) – palpate (only sheep/goats and game/antelope);
- renal (Figure 8.4) – palpate (cattle, horses, pigs) or incise if disease is suspected;
- prescapular (Photo 8.10) and prefemoral – palpate (only sheep and goats).

Other

The muscles and the lymph nodes (lymphonodi sub-rhomboidei) beneath one of the two scapular cartilages of all grey or white horses should be examined for melanosis after loosening the attachment of one shoulder.

SUPERVISION OF HYGIENIC DRESSING OF CARCASSES

During dressing the carcass is exposed to contamination from:

- the abattoir environment, including implements used and the hands of the operators: a variety of bacteria, fungi and yeasts are present in the abattoir environment. Studies in abattoirs indicate that *Salmonella* counts in the implements used may vary from 0–270 per cm^2 or more in each implement, depending on their regular cleaning and sanitation, the scabbards having the highest numbers;
- the hides of the animals: hides are heavily contaminated parts and can reach up to 3×10^6 bacteria per cm^2 or more;

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PHOTO 8.5
Viewing and incision of the mesenteric lymph nodes: in this case an incision was performed to demonstrate the mesenteric lymph nodes chain

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PHOTO 8.7
Medial view of the hindquarter: superficial inguinal, internal and external iliac and lumbar lymph nodes are palpated and incised in systemic or generalized disease

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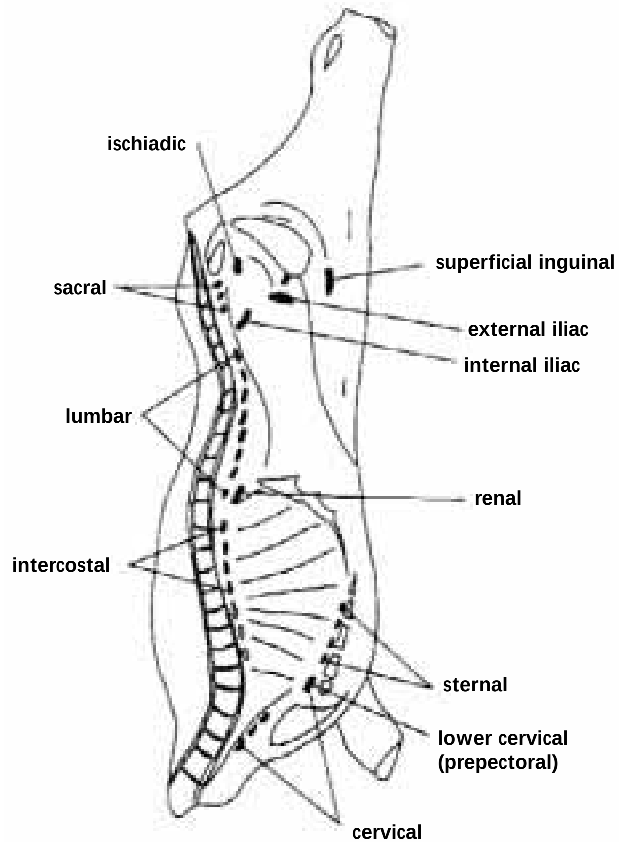
PHOTO 8.6
Superficial inguinal and internal and external iliac lymph nodes in a pig: viewed and palpated on routine post-mortem examination

PHOTO 8.8
Medial view of the forequarter with intercostal, suprasternal, presternal and prepectoral lymph nodes: presternal and prepectoral lymph nodes are incised

PHOTO 8.9
Popliteal lymph nodes in a pig: these nodes are incised if a systemic or general disease is suspected

FIGURE 8.4 **Medial view of carcass with relevant lymph nodes**



Source: D. Herenda, Canada.

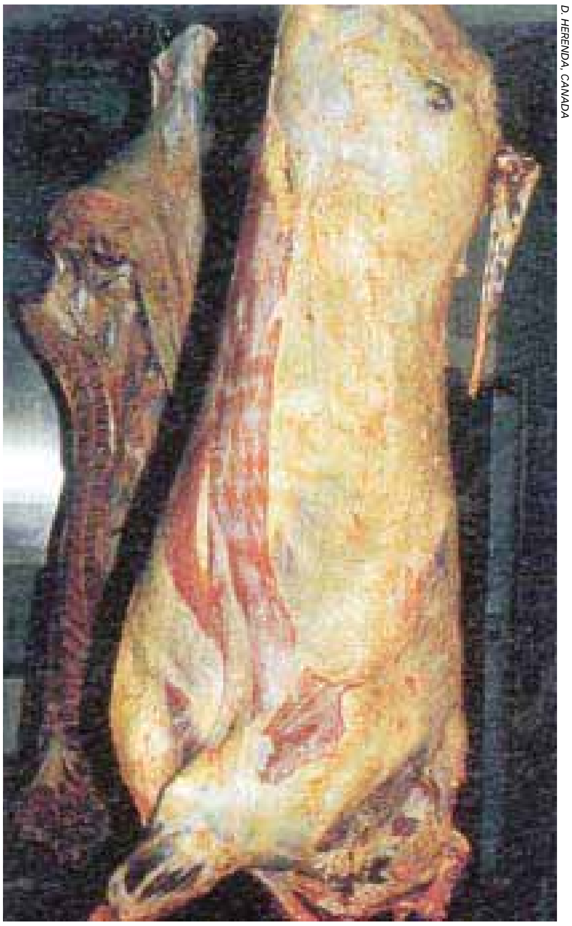


PHOTO 8.10
Lateral view of the carcass: precrural and prescapular lymph nodes are incised in systemic or generalized disease

- the stomach and gastro-intestinal contents: gastro-intestinal contents have the heaviest load of micro-organisms. Faeces contain up to 9.0 x 10^7 bacteria per gram, and various numbers of yeast and mould. The ruminal contents have only slightly lower numbers of micro-organisms.

Therefore, during meat inspection it is an important duty of the inspecting officer to ensure that:

- the implements used during slaughtering, dressing and meat inspection are well sanitized periodically, or whenever they are likely to be contaminated;
- during cutting into the hide and exposure of the carcass, the external surface of the hide does not come into contact with the carcass meat;
- the viscera are not accidentally opened during the dressing procedures or during evisceration.

If a carcass or part is contaminated with faeces or visceral contents, such areas should be trimmed off. The opened viscera should be separated from the rest of the carcass as quickly as possible.

The introduction of a Hazard Analysis and Critical Control Point (HACCP) concept can be helpful to maintain high standards of slaughter and dressing hygiene based on an assessment of the risks to human and animal health.

GENERAL PATHOLOGICAL CONDITIONS

For a full description of the conditions and more information on ante-mortem findings, differential diagnosis and judgement refer to Section 6.

Fever (pyrexia)

Post-mortem findings:

- rigor mortis;
- putrefaction;
- congestion of subcutaneous blood vessels and entire carcass;
- enlarged lymph nodes;
- evidence of cloudy swelling of liver, heart and kidneys.

Judgement:

Carcass is condemned if fever syndrome is associated with presence of bacteria or bacterial toxins in the blood and/or findings of drugs and antimicrobial substances.

If typical signs of fevered carcass are not seen, the carcass should be held for 24 hours after slaughter and re-examined. In the case of mild fevered syndrome detected first on post-mortem inspection, the carcass may be conditionally approved with heat treatment providing that bacteriological and chemical tests are negative.

Septicaemia

Post-mortem findings:

- enlarged oedematous or haemorrhagic lymph nodes;
- degenerative changes in parenchymatous organs (liver, heart and kidneys);
- congestion and petechial or ecchymotic haemorrhages in kidney, heart surface, mucous and serous membranes, connective tissue and panniculus adiposis;
- splenomegaly;
- inadequately bled-out carcass as a result of high fever;
- blood-stained serous exudate in abdominal and/or thoracic cavities;
- anaemia resulting from bone marrow depression and icterus may also be present.

One or more lesions may be absent. However, if one significant lesion is present, such as generalized acute lymphadenitis, the carcass must be condemned. All gross lesions in the carcass and organs must be considered before the animal is judged septicaemic. Septicaemia is found in many infectious diseases including acute forms of salmonellosis, leptospirosis, swine erysipelas, hog cholera and in anthrax in cattle.

Judgement:

The animals, animal carcasses, offal and other detached portions of animals affected with septicaemia are condemned. In borderline cases bacteriological examination should be carried out wherever possible.

Toxaemia

Post-mortem findings:

- haemorrhage in organs;
- normal or enlarged and oedematous lymph nodes (not hyperplastic as in septicaemia);
- areas of tissue necrosis;
- emphysema in cattle;
- rarely, degenerative changes of parenchymatous organs (heart, liver and kidneys).

Judgement:

If there is evidence of septicaemia or toxaemia the carcass and the viscera should be condemned and the implements used during inspection and the hands and arms of the inspector should be washed and disinfected. The primary lesions causing septicaemia or toxaemia, including metritis, mastitis, pericarditis and enteritis should be observed and recorded as causes of condemnation.

Pigmentation

Pigments are classified as exogenous and endogenous. Exogenous pigments are synthesized outside the body and endogenous within the body itself. Pigments are coloured substances that accumulate in the body cells during the normal physiological process and abnormally in certain tumours and conditions. They have different origins, biological significance and chemical composition.

In anthracosis, carbon particles are found as a black pigment in tissues. This condition is seen as black pigment of the lungs and corresponding lymph nodes in animals raised in urban areas. The lungs affected with anthracosis are condemned and the carcass is approved.

The carotenoid pigments are exogenous pigments, greenish-yellow in colour, which consist of carotene A, carotene B, and xanthophyll. They are important in meat inspection because they cause yellowish discoloration in the fat and muscles of (Jersey and Guernsey) cattle. Carotenoid pigments should be differentiated from bile pigments in icterus. The bovine liver affected with this condition is enlarged and shows a bright yellow colour. Such a liver is condemned with the rationale that the affected liver demonstrates some toxic changes, as damaged liver cells cannot metabolize carotene. Liver carotenosis must be differentiated from pale livers in advanced pregnancy.

The endogenous pigments, except for melanin and lipofuscin, are derivates of haemoglobin.

Melanosis

Melanosis is an accumulation of melanin in various organs including the kidneys, heart, lungs and liver (Photo 8.11), and other locations such as brain membranes, spinal cord, connective tissue and periosteum. Melanin is an endogenous brown-black pigment randomly distributed in tissue. In grey and white horses,

P. MASZTIS, WESTON VET. CLINIC, CANADA

PHOTO 8.11
Melanin deposits in sheep viscera

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PHOTO 8.12
Myocardial lipofuscinosis

MOSBY YEAR-BOOK INC., USA

PHOTO 8.13
Osteohaemochromatosis showing reddish-brown pigmentation of ribs and vertebrae in a six-month-old calf

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PHOTO 8.14
Jaundice of an aged cow caused by liver disease: note yellow discoloration of body fat, lungs, heart and kidneys

this pigment is found under the shoulder, axillary area and *ligamentum nuchae*. Melanin is also found in lymph nodes, pig skin and belly fat or mammary tissue in female pigs. This condition is called seedy belly or seedy cut since the black colour in the mammary tissue resembles round, black seeds. The melanotic tissue in pigs shows a tendency towards neoplasia. Melanin deposits in the oesophagus and adrenal glands in older sheep are a common finding on post-mortem examination. Multifocal deposits of melanin in the liver of a calf are known as *Melanosis maculosa*. It is common in calves and it usually disappears after the first year of age.

Judgement:
Carcasses showing extensive melanosis are condemned. If the condition is localized, only the affected organ or part of the carcass needs to be condemned.

Differential diagnosis:
Haemorrhage, melanoma, distomatosis (liver flukes).

Myocardial lipofuscinosis (brown atrophy of the heart, xanthosis)

Xanthosis (wear-and-tear) pigment is a brown pigmentation of skeletal and heart muscles of cattle (Photo 8.12). The condition is seen in old animals such as cull dairy cows and in some chronic wasting diseases. It is prevalent in Ayrshire cows and approximately 28 percent of normal Ayrshire cows have this pigment in skeletal and heart muscles. Xanthosis is not dependent on the age of animals in this breed.

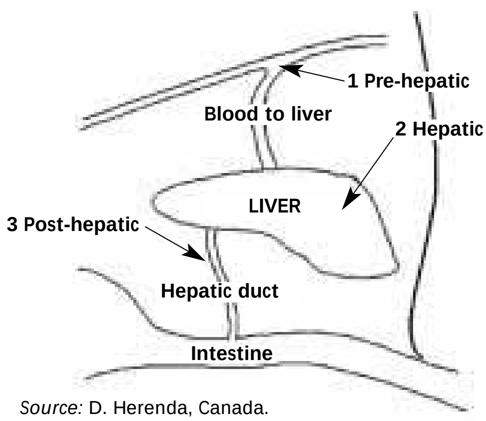
Congenital porphyria (osteohaemochromatosis, pink tooth)

Porphyria is the accumulation of plant or endogenous porphyrins in the blood resulting in tissue pigmentation and photosensitization. This is a hereditary disease and is observed in cattle, swine and sheep. In porphyric cattle, exposure to light will initiate the development of photodynamic dermatitis. In swine, photodynamic dermatitis does not occur.

The disease is also known as osteohaemochromatosis, due to a reddish-brown bone pigmentation (Photo 8.13), and pink tooth because of a brownish-pink discoloration of teeth.

PHOTO 8.15
Yellow discoloration of pig viscera and carcass caused by cirrhosis of the liver

FIGURE 8.5 **Classification of jaundice**



Source: D. Herenda, Canada.

Judgement:
A carcass showing extensive xanthosis is condemned. If the condition is localized, only the affected organ or part of the carcass needs to be condemned. The head and bones of a carcass affected with osteohaemochromatosis are condemned. The bones are boned out and the remaining muscles are approved. If the condition is generalized, the carcass is condemned.

Icterus (jaundice)

Icterus is the result of an abnormal accumulation of bile pigment, bilirubin or of haemoglobin in the blood. Yellow pigmentation is observed in the skin, internal organs (Photos 8.14 and 8.15), sclerae (the white of the eye), tendons, cartilage, arteries, joint surfaces, etc. Icterus is a clinical sign of a faulty liver or of bile duct malfunction, but it may be also caused by diseases in which the liver is not impaired, such as haemolytic crisis caused by blood parasites of *Babesia* spp.

Jaundice is divided into three main categories (Figure 8.5):

- pre-hepatic jaundice (haemolytic icterus);
- hepatic jaundice (toxic icterus);
- post-hepatic jaundice (obstructive icterus).

Pre-hepatic jaundice

Pre-hepatic jaundice occurs following excessive destruction of red blood cells. Tick-borne diseases such as *Babesia ovis* and anaplasmosis cause this type of icterus, which is one of the main causes of carcass condemnation in southern Africa due to prevalence of these parasites. Overproduced blood pigment, which cannot be metabolized in the liver, builds up in the blood (haemoglobinaemia). It is excreted by the kidneys into the urine (haemoglobinuria). Normal urine colour changes and becomes bright red to dark red.

Hepatic jaundice

Hepatic jaundice occurs due to direct damage to liver cells as seen in liver cirrhosis (Photo 8.15), systemic infections, and in chemical and plant poisoning. In sheep, jaundice may have been caused by phytogenic chronic copper poisoning.

Liver function is impaired and the liver is unable to secrete bile pigments. Obstructive jaundice occurs when the drainage of the bile pigment bilirubin is blocked from entry into the intestine. This usually occurs due to the obstruction of the hepatic ducts by a tumour, by parasites such as flukes or by gall stones. Obstruction may also occur due to an inflammation of the bile ducts. In hogs, mature ascarides may occlude the bile ducts.

Judgement:

Animals suspected to have icterus should be treated as suspects on ante-mortem examination. On post-mortem examination, the carcass and viscera with haemolytic, toxic icterus and obstructive icterus are condemned. Less severe cases are kept in the chiller for 24 hours. Upon re-examination, the carcass may be approved or condemned depending on the absence or presence of pigment in the tissue. If the obstructive icterus disappears after 24 hours, the carcass and viscera can be passed for human consumption.

A simple laboratory test will help to make an objective test for bile pigment icterus. Two drops of serum are mixed on a white tile with two drops of Fouchets agent (see below). A blue/green precipitate is positive for bile icterus.

Fouchets Reagent Trichloroacetic acid	25 gm
$FeCl_3$ (10% solution)	10 ml
Distilled water	100 ml

Differential diagnosis:

Yellow fat in animals with heavy maize rations, nutritional panniculitis (yellow fat disease, steatitis) and yellow fat seen in extensive bruises. In yellow fat disease, the fat has a rancid odour and flavour upon cooking.

To differentiate icterus from the normal colour of fat of certain breeds, the sclera, intima of the blood vessels, bone cartilage, liver, connective tissue and renal pelvis should be examined. If yellow discoloration is not noted in these tissues, icterus is not present.

Icterus should not be confused with yellow fat disease in hogs fed predominantly on fish by-products or by the yellowish appearance of tissue caused by breed characteristics or nutritional factors.

Haemorrhage and haematoma

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PHOTO 8.16
Fractured bone and muscle haemorrhage in a market hog

Haemorrhage is seen at slaughter in various organs, mucous and serous membranes, skin, subcutaneous tissue and muscles. It may be caused by trauma, acute infectious diseases or septicaemia.

In pig muscles, haemorrhage is frequently associated with fractures (Photo 8.16). Petechial haemorrhage is noted as tiny foci 1–2 mm in diameter. Ecchymotic haemorrhage (Photo 8.17) is larger, being up to 2–3 cm in size. Paintbrush haemorrhage includes extensive streaking with haemorrhage. Haemorrhage is also associated with vitamin C deficiencies, a sudden increase in blood pressure with weakened blood vessels, and improper electric current stunning in pigs and sheep. Lengthy transportation, exposure to stress before slaughter, hot weather and excitement are some of the other factors that contribute to muscle haemorrhage.

In haemorrhage caused by improper stunning, there may be a delay between stunning and sticking of the animal. The electrical current used in stunning causes cardiac muscle stimulation and vasoconstriction of blood vessels. This might induce a rapid rise in blood pressure leading to haemorrhages in the organs and muscle (so-called blood splashing).

The stunning of animals by a mechanical blow to the head is still practised with sheep and is a significant cause of haemorrhage in organs, particularly the lungs and heart. The blow to the head will initiate a rise in blood pressure. The

PHOTO 8.17
Ecchymotic haemorrhage in the tongue muscle of a cow

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normal arterial blood pressure in sheep is 120–145 mm Hg. This may rise to 260 mm Hg or over in a stunned animal. The heart rate will be increased. Immediate bleeding with the fast blood flow from the cut vessels could prevent this type of haemorrhage in sheep.

Agonal haemorrhage (due to rupture of capillaries) is caused by laboured breathing and contraction of musculature during violent death.

A lump formed from a blood clot in tissues or organs is called a haematoma. Haematomas vary in size and may be over 1 m in diameter (Photo 8.18). They are associated with trauma or a clotting defect. Haematoma of the spleen (Photo 8.19) may be associated with head butting by horned animals.

Judgement:

A carcass is approved if the haemorrhage is minor in extent and is due to physical causes. The affected tissue is condemned. A carcass affected with extensive haemorrhage where salvaging is impractical, or a haemorrhagic carcass associated with septicaemia, is condemned.

Differential diagnosis:

Haemorrhage resulting from blackleg, and sweet clover poisoning.

PHOTO 8.18
Haematoma in the abdominal wall of a ewe

D. HERENDA, CANADA

P.G. CHAMBERS, ZIMBABWE

PHOTO 8.19
Haematoma of the bovine spleen

Bruises

Judgement:
On post-mortem examination, carcasses affected with local bruising are approved after being trimmed. Carcasses affected with bruises or injuries associated with inflammatory lesions are also approved if tissue reaction does not extend beyond the regional lymph nodes. The affected area should be condemned. When bruises or injuries are associated with systemic change and the wholesomeness of the musculature is lost, the carcass will be condemned.

On post-mortem examination of carcasses affected with bruises and fractures, the following judgement should be observed: (a) the fractures associated with bruises are removed and affected tissue is condemned; (b) in compound fractures with damaged skin, the fractured site and surrounding tissues are condemned; (c) in simple fractures without bruises and damaged skin, the affected portion may be approved for mechanical and manual boning operations. If the lower part of the bone is fractured, the bone may be removed by cutting above the fracture. A carcass affected with extensive bruises is condemned on post-mortem examination (Photo 8.20). A slightly or moderately bruised carcass is approved if no systemic changes are present. Affected tissues are condemned.

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PHOTO 8.20
Extensive bruises on a beef carcass

Abscesses

The most common bacteria in liver abscesses include *Actinomyces* (*Corynebacterium*) *pyogenes*, *Streptococcus* spp. and *Staphylococcus* spp. In the lungs, the most common bacteria are *Pasteurella* spp. and *Actinomyces pyogenes*. *Fusobacterium necrophorum* causes liver abscesses (Photo 8.21) as a complication of rumen inflammation (rumenitis) in adult cattle. This condition is common in feedlots where cattle are fed a high grain diet that produces acidity in the rumen and ulcerative rumenitis. The rumen lesion is invaded by *F. necrophorum* which pass further via the veins to the liver and stimulate abscess formation.

Judgement:
The judgement of carcasses affected with abscesses depends on findings of primary or secondary abscesses in the animal. The portal of entry of pyogenic organisms into the system is also of importance. The primary abscess is usually situated in tissue that has contact with the digestive tract, respiratory tract, subcutaneous tissue, liver, etc. The secondary abscess is found in tissue where contact with these body systems and organs is via the

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PHOTO 8.21
***Liver abscesses caused by* F. necrophorum**

bloodstream. The brain, bone marrow, spinal cord, renal cortex, ovary and spleen (Photo 8.22) may be affected with secondary abscesses. In judgement of the carcass, the inflammation of the renal medulla and contact infection in the spleen and ovaries must be ruled out. A single huge abscess found in one of the sites of secondary abscesses may cause the condemnation of a carcass if toxaemia is present. In pigs, abscesses are frequently observed in the jaw and in the spine. Spinal abscesses in pigs are commonly caused by tail biting (Photo 8.23). The bacterial agent from the tail penetrating the spinal canal could be arrested in the lumbo-sacral and cervical spinal enlargements, initiating an abscess formation.

Inspectors should differentiate abscesses in the active and growing state from the older, calcified or healed abscesses. In domestic animals, the primary sites of purulent infections are post-partum uterus, umbilicus or reticulum in hardware disease. Secondary abscesses are frequently observed in distant organs. Small multiple abscesses may develop in the liver of calves as a result of infection of the umbilicus (sawdust liver , Photo 8.24). Carcasses with such condition should be condemned.

On post-mortem examination, the carcasses are condemned for abscesses, if the abscesses resulted from entry of pyogenic organisms into the bloodstream and into the abdominal organs, spine or musculature. An abscess in the lungs may require condemnation of the lungs and passing of the carcass if no other lesions are noted. Liver abscesses associated with umbilical infection require condemnation of the carcass. If no other infection is present, the abscess is trimmed off and the liver may be utilized for human or animal food depending on the regulations of the respective country. Multiple abscesses in the liver require condemnation of the organ.

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PHOTO 8.22
Secondary abscesses in the spleen of an aged cow

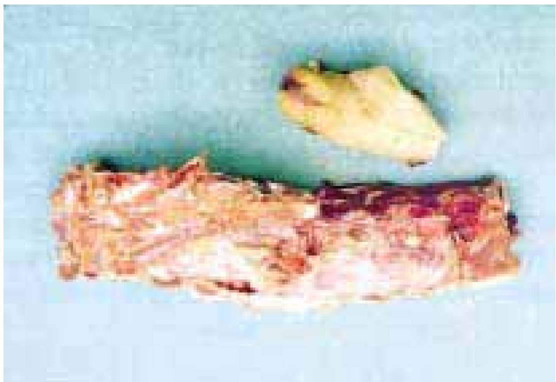

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PHOTO 8.23
Tail necrosis caused by biting and secondary spine abscesses

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PHOTO 8.24
Multiple abscesses in a calf liver as a result of an umbilical infection; a carcass with such a condition should be condemned

Emaciation

Emaciation is associated with gradual diminution in the size of organs and muscular tissue as well as oedema in many cases. The organs and muscular tissue appear thinner, moist and glossy. Emaciation is a post-mortem descriptive term that should be differentiated from thinness.

Post-mortem findings:

- serous atrophy of fat in the carcass and organs, especially the pericardial and renal fat (Photo 8.25);
- the fat is watery, translucent or jelly-like and hangs from the intervertebral spaces (Photo 8.26);
- oedema and anaemia may develop due to starvation and malnutrition due to parasite infestations.

Judgement:

On post-mortem examination it is important to assess and differentiate emaciation from leanness. In case of doubt, the carcass may be held in the refrigerated room and the general setting of the carcass should be examined the following day. If the body cavities are relatively dry, oedema of muscle tissue is not present and the fat is of an acceptable consistency, i.e. has set , the carcass may be passed for food.

Well nourished carcasses with serous atrophy of the heart and kidneys and mere leanness may also be fit for human consumption. A carcass with any amount of normal fat may be approved if everything else appears normal. The carcasses from animals that have been in transport for a long period of time may show extensive serous atrophy of fat (mucoid degeneration of fat tissue) without any changes in organs and muscles. If, after being in the cooler for 24–48 hours, the fat resumes its normal consistency, the carcass is approved. Otherwise, the carcass is condemned.

The carcass and viscera must be condemned if emaciation is due to chronic infectious disease. An objective judgement of emaciation with oedema may be made using a 47% ethanol in water solution. A clear, pea-sized piece of bone marrow, taken from the distal radius, is put carefully into the solution. If it sinks, the marrow, which reflects the water content of the carcass as a whole, has approximately 45 percent water content. The carcass should be condemned.

Differential diagnosis:

Thinness-leanness, oedema and uraemia.

Leanness (poorness) is often observed in range bulls on poor-quality pasture, high-milking cows and young growing animals that have had protein-deficient diet. The animals are physiologically normal and the reduced fat deposits of the animal carcass are normal in colour and consistency. The reduced muscle tissue is firm and of a normal consistency. The muscle colour is darker than normal, and fat tissue may still be present in the orbit of the eye.

PHOTO 8.25
Serous atrophy of renal fat: note petechial haemorrhages, seen frequently in septicaemic diseases

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PHOTO 8.26
Hanging gelatinous fat between the spinal processes

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Oedema

Post-mortem findings:

- wet, sloppy musculature that pits on pressure;
- accumulation of clear or faint yellow fluid in the thorax, abdomen and subcutaneous tissue.

Judgement:

When making a judgement of a carcass affected with oedema, it is important to know the underlying cause of the oedema and also to know the significance of all other lesions found in the carcass.

The carcass may be totally or partially condemned depending on the extent and cause of the condition. The presence of localized oedema necessitates removal of the affected area. The carcass is then approved. Oedema associated with diseased conditions such as traumatic pericarditis, malignant neoplasm or septicaemia requires condemnation of the carcass because of the primary condition. Oedema observed in the mesentery is commonly related to circulation interference in the caudal vena cava resulting from liver abscess or chronic liver disease. Such a carcass may be held in the cooler for re-examination. Dry serous membranes of the abdominal and thoracic walls and a carcass appearing normal after re-examination can be passed for human consumption. Carcasses that have been condemned for oedema associated with malnutrition only may be salvaged for animal food (except in the case of oedema associated with septicaemia).

Differential diagnosis:

Pericarditis, peritonitis, pleuritis, renal amyloidosis, liver disease, grain overload and vagal indigestion, high altitude disease and uraemia.

Emphysema

Emphysema in animals is associated with some disease conditions and is caused by an obstruction to the outflow of air or by extensive gasping respiration during slaughter procedures.

All species may be affected by alveolar emphysema. However, interstitial emphysema (Photo 8.27) occurs mostly in cattle. In the latter, the lack of collateral ventilation forces the rupture of alveoli and the migration of air into the interstitium. The lobules of the lungs become separated by the distended interstitial tissue and marked lobulation of lungs is observed.

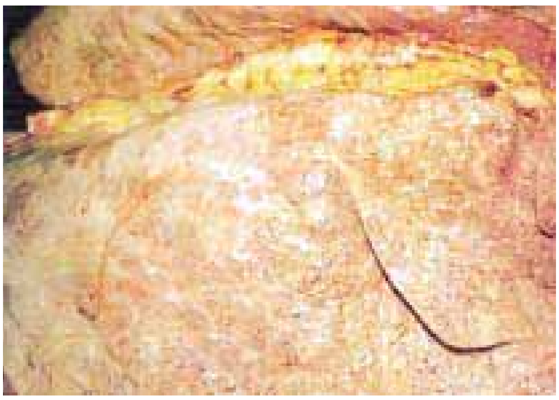

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PHOTO 8.27
Interstitial emphysema in a cow's lungs

Alveolar emphysema appears as small air bubbles due to air trapped in dilated alveoli. Large accumulations of air, a few centimetres in diameter, are called bullae or bullous emphysema .

Post-mortem findings:

Post-mortem findings of the emphysematous lungs include a pale, enlarged greyish-yellow, pearl-like shiny lesion. Upon palpation, the affected area feels puffy and crepitant.

Two diseases of food animals associated with emphysema are chronic obstructive pulmonary disease (COPD) in horses, and interstitial pneumonia in cattle. COPD is also called heaves and frequently described under chronic bronchitis or bronchiolitis in horses. Interstitial pneumonia in cattle is also described under fog fever or acute chronic pulmonary oedema and emphysema.

Judgement:

Affected lungs are condemned.

Tumours or neoplasms

A tumour is an abnormal mass of tissue that grows without control and uncoordinated with the tissue or organs of origin or those nearby. Its presence is often cumbersome to the tissue or organ. It arises either by pressure or by replacement of normal functional tissue. Tumour cells resemble healthy cells but serve no useful purpose. The term tumour in current medical lexicon is limited to neoplastic growths.

PHOTO 8.28
Squamous cell carcinoma affecting cow's eye and parotic lymph node. In this case, tumour lesions were also observed in the lungs; the carcass was condemned

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Tumours are usually divided according to the tissue of origin, i.e. epithelial, mesenchymal (connective tissue), haemopoietic, nervous, etc. Tumour behavioural classification includes their mode of growth and the degree of invasiveness. Slow-growing, non-invasive circumscribed tumours are considered benign, and fast-growing, infiltrative and frequently metastatic tumours are malignant. The spread of neoplasm is by direct expansion and infiltration, via lymphatics and blood circulation, and by implantation. Carcinomas are tumours of the epithelial tissue. They are usually spread via the lymphatic system. Sarcomas are connective tissue tumours, commonly spread via haematogenous route. Implantation to surrounding parietal cavities is observed in ovarian carcinomas. The spread of malignant tumours via lymphatics, or haematogenous spread to another area not directly connected with the original site, is called metastasia .

Some of the common tumours found during beef inspection are squamous cell carcinoma (Photo 8.28), lymphosarcoma, pheochromocytoma and mesothelioma.

Judgement:

A carcass affected with metastatic neoplasms is condemned. Multiple benign tumours in different organs also require condemnation of the carcass. A carcass affected with circumscribed benign tumours is approved after removal of the tumours.

Calcification

Calcification is the deposition of calcium salts in dead and degenerating tissue. It may be regarded as a body reaction to immobilize some foreign agents. It may occur in any tissue or organ. In dairy cows, calcification is noted in the heart (endocardium) and is caused by excessive dietary supplementation with Vitamin D. In cattle, mineralization of the aorta and brachiocephalic trunk (Photo 8.29) is sometimes seen. Calcification is also seen in parasitic infections (Photo 8.30) and in many chronic infections such as tuberculosis and botryomycosis. The presternal pressure necrosis of fat (putty brisket) seen in cattle and rarely in sheep may also eventually mineralize. Inflammatory metaplasia leading to ossification is an incidental finding during post-mortem examination of food animals. It is most commonly found in peritoneal scars of hogs.

If calcium particles are removed from the surrounding tissue, they appear white or grey, irregularly rounded and frequently honeycombed. Calcification is detected on post-mortem examination by a gritty sound upon incision with a knife.

Judgement:

A carcass and viscera affected with presternal calcification are approved. Affected brisket is condemned. Calcified parasitic organs and heart in dairy cows are also condemned.

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PHOTO 8.29

Calcification of the aorta and brachiocephalic trunk in a young heifer

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PHOTO 8.30

Parasitic lesions undergoing mineralization in a sheep's liver

Degeneration

Degeneration implies the change of tissue to a lower or less functionally active form, or deterioration (impairment) of an organ or cell due to changes in its size. If chemical change of the tissue occurs, this is regarded as a true degeneration. Cloudy swelling (parenchymatous degeneration, albuminous degeneration or granular degeneration, acute cellular swelling) in the cell is a response to cell insults, including trauma, anoxia, immune mechanisms, toxins, viral and bacterial agents. In cloudy swelling, cell proteinaceous substances become cloudy and the cell increases in size. It is observed in the heart, kidneys, liver, glands and muscles.

Cloudy swelling is often associated with fatty degeneration. Affected organs are pale, lustrous and softer than normal, slightly enlarged and have the appearance of having been boiled (Photo 8.31). In slight insults, the animal may recover and in severe cases cloudy swelling is succeeded by fatty degeneration.

Fatty infiltration is an accumulation of fat in the heart, liver, kidneys, pancreas, etc. The liver is yellow, soft in consistency, has round edges, dimples on pressure, is enlarged and has a greasy texture on cut surfaces. Fatty infiltration may disappear from the tissues if the causative agent is removed. The extensive accumulation of fat in the liver is caused by an increased dietary intake of fat, increased mobilization of fat during lactation or starvation. It is also seen in healthy animals slaughtered shortly after parturition and often accompanies advanced pregnancy in cows and ewes.

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PHOTO 8.31
Degeneration, cloudy swelling and associated fatty change in a pig's liver

Fatty degeneration is an irreversible process and occurs when fat accumulates in the damaged cell. The liver capsule is dull and has a turgid appearance. This condition is associated with acute febrile and toxic conditions and with chemical poisoning by arsenic, phosphorus, chloroform, etc. The liver and kidneys affected are a pale, clay-red colour and greasy on touch. They have a patchy or spotted appearance.

Judgement:
Organs and muscles affected with cloudy swelling are condemned. Detailed examination of the carcass is necessary since systemic changes are usually present and the carcass is therefore condemned. A liver affected with fatty infiltration is approved.

Telangiectasis

This liver condition is found in cattle, sheep and horses. It is more frequent in older cows. The liver lesions are bluish-black and irregular with depressed surfaces and dilated blood-filled hepatic sinusoids. A cause of hepatic telangiectasis (Plum pudding , Photo 8.32) in cattle is thought to be local ischaemia.

Judgement:
A slightly affected liver is approved after appropriate trimmings. An extensively affected liver requires condemnation. Condemned material can be used for animal food.

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PHOTO 8.32
Bovine liver affected with telangiectasis

Abnormal odours

Abnormal odours may result from the ingestion of certain feedstuffs, drugs, various pathological conditions, absorption of odours from strong smelling substances and sexual odour from some male animals. Pig carcasses may have a fishy odour if the pig was consuming excessive fishmeal in the diet or was fed codfish oil. Drugs that may cause absorption of odours include turpentine, linseed oil, carbolic acid, chloroform, ether and aromatic spirits of ammonia.

In cows affected with ketosis, the sweetish odour of acetone may be present in the muscles. If treatment was not successful in dairy cows affected with milk fever, the odour of acetone may be noted in the connective tissue, kidney fat and musculature. The flesh of bloated and constipated animals may give off a faecal odour. If the meat is kept in a room that was recently painted, the odour may pass on to the carcass. The odour is most noted in a carcass right after slaughter.

Judgement:

A carcass with fishmeal odour has inferior meat. Viscera and organs are also inferior. Generalized drug treatment requires that the carcass be condemned. However, if local treatment and withholding periods are observed, the carcass and viscera can be approved.

Sexual odour in a carcass can have a limited distribution according to consumers' tastes. Extremely strong sexual odour requires condemnation of the carcass.

A carcass that gives off a pronounced odour of medicinal, chemical or other foreign substances should be condemned. If the odour can be removed by trimming or chilling, the carcass may be passed for human food consumption after the removal of affected parts or dissipation of the condition.

Carcasses affected with sexual odour should be held in the cooler and re-tested periodically. If the odour disappears, the carcass is approved. If the sexual odour is present after 48 hours, the carcass should be condemned. Young boars and ridglings are treated as suspects and held pending a heat test.

If abnormal odour is suspected, the smell will be enhanced by placing a piece of muscle or tissue in cold water and bringing to the boil.

Immaturity

The muscle of immature animals is moist, pale, flabby and poorly developed. It is low in protein and high in water content, and the carcass contains a high proportion of bone. Immature animals should not be slaughtered for human consumption.

Post-mortem findings:

- presence of the umbilical cord;
- bluish and not completely retracted gums;
- greyish muscles are flabby, tear easily and are not well developed;
- dark red kidney and oedematous kidney capsule.

Judgement:

The carcass and offal of immature animals are condemned.

Remarks:

The presence or non-presence of fat around the kidneys (caul fat) should not be used as a guide for judgement of immature animals.

Plant and chemical poisoning

Clinical signs of poisoning are discussed in Section 6.

Gross lesions may include gastro-enteritis, fatty degeneration of the liver and inadequate bleeding.

Judgement:
The carcass, offal and intestine should be condemned if clinical signs of poisoning are associated with post-mortem lesions.

Spear grass penetration of sheep

Grassland in many parts of Africa contains scattered grasses with spear-like seeds. These seeds may penetrate through the wool and skin to the subcutis, and further through the abdominal wall into the abdominal cavity.

Post-mortem findings:
- spear-like seeds in the wool and skin;
- spear-like seeds in the connective tissue, fat and musculature (Photo 8.33);
- acute inflammation of the affected tissue;
- abscessation;
- spear-like seeds in the abdominal cavity causing low-grade peritonitis.

Judgement:
If an acute generalized inflammation is associated with haemorrhages and abscesses, the carcass should be condemned; otherwise the carcass is approved.

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PHOTO 8.33
Spear grass penetration of sheep: numerous spear-like seeds in the sheep carcass

SPECIFIC DISEASES

DISEASES CAUSED BY VIRUSES

Foot-and-mouth disease (FMD)

Post-mortem findings:

- necrosis of heart muscle (tiger heart), usually only in young, acutely infected animals;
- ulcerative lesions on tongue, palate, gums, pillars of the rumen and feet.

Judgement:

If FMD is suspected on post-mortem examination, the carcass and viscera are condemned and appropriate action recommended by the regulatory authorities of the country must be taken. In countries where this disease is present, the judgement should be in accordance with the current animal health requirements, and consistent with effective public health protection. Particular attention should be paid to secondary bacterial infections and general findings. Sanitary measures should be taken to comply with national animal health policy.

Rinderpest (RP)

Post-mortem findings:

- punched-out erosions in the oesophagus;
- oedema or emphysema of the lungs;
- haemorrhage in the spleen, gall bladder and urinary bladder;
- haemorrhagic or ulcerative lesions in the omasum;
- congested abomasum filled with bloody fluid (ulcers may also be observed);
- severe congestion and haemorrhage in the intestine and enlarged and necrotic Peyer's patches (Photo 8.34);
- last portion of the large intestine and rectum are haemorrhagic showing tiger striping of longitudinal folds;
- enlarged and oedematous lymph nodes;
- emaciated carcass.

Judgement:

A carcass derived from a feverish and debilitated animal showing the signs of acute disease on ante-mortem examination should be condemned. In endemic zones, if acute symptoms of the disease are not present during clinical examination, the carcass may have limited distribution. In areas affected with an outbreak that are protected by vaccination, heat treatment of meat is suggested if economically worthwhile. The affected organs are condemned.

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PHOTO 8.34
The mucosal surface of Peyer's patches showing necrosis and congestion

Vesicular stomatitis (VS)

Post-mortem findings:

- the skin and mucous membrane lesions resemble the lesions of other vesicular diseases;
- secondary bacterial or fungal infections;
- mastitis.

Judgement:

The carcass of an animal affected with VS is approved if the disease is not in the acute stage and secondary changes are not present. Parts of the affected carcass and organs are condemned. A carcass showing acute changes and systemic lesions is condemned. If VS is not confirmed by laboratory examination, the judgement will be the same as for FMD.

Malignant catarrhal fever (MCF)

Post-mortem findings:

- lesions are not present in acute cases;
- crater-like erosions of the nose, mouth, conjunctiva, oesophagus and gastro-intestinal tract;
- lungs may be congested, swollen or emphysematous;
- white areas in the kidneys;
- swollen and reddened abomasal folds;
- intestinal oedema and petechial haemorrhage;
- tiger striping in the distal colon (Photo 8.35);
- enlarged and reddened lymph nodes;
- dehydrated and emaciated carcass.

PHOTO 8.35
MCF: "tiger striping" in the distal colon

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Judgement:

In the early stages of the disease, when fever, emaciation and systemic signs are lacking, the carcass of the affected animal may be approved as inferior meat. Otherwise, when fever, emaciation and systemic signs are present, the entire carcass and viscera are condemned. The condemned material may be used for rendering.

Rabies

Post-mortem findings:

- possible inflammation of gastro-intestinal mucosa.

Judgement:

In endemic areas, carcasses may be approved if the animal was bitten no more than 48 hours before slaughter. The bite area and surrounding tissue must be condemned, and precautions taken to prevent occupational hazards.

Lumpy skin disease

Post-mortem findings:

- ulcerative lesions in the mucosa of the respiratory and digestive tract;
- reddish, haemorrhagic to whitish lesions in the lungs;
- oedema (interlobular) and nodules in the lungs (Photo 8.36);
- heart lesion (endocardium);
- thrombosis of skin vessels followed by cutaneous infarction and sloughing.

Judgement:

The carcass of an animal showing mild cutaneous lesions and no fever associated with general signs of infection is conditionally approved pending heat treatment. The affected parts of the carcass and organs are condemned.


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PHOTO 8.36
Cut surface of the nodules in the parenchyma of the lung and interlobular oedema

Bovine herpes dermophatic disease (BHD)

Post-mortem findings:

- microscopy reveals intranuclear inclusions and giant cells in the skin.

Judgement:

The carcass of an animal affected with BHD is disposed of in a similar manner to that of an animal affected with lumpy skin disease.

Infectious bovine rhinotracheitis (IBR)

Post-mortem findings:

- acute inflammation of the larynx, trachea (Photo 8.37) and bronchi;
- profuse fibrino-purulent exudate in the upper respiratory tract in severe cases;
- chronic ulcerative gastro-enteritis in feedlot cattle;
- lung emphysema;
- secondary bronchopneumonia.

Judgement:

The carcass of an animal affected with IBR is approved if signs of acute infection are not present and the animal is in good body condition.


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PHOTO 8.37
IBR: acute inflammation of the larynx and trachea

Bovine viral diarrhoea (BVD)

Post-mortem findings:

- shallow erosions present on the entrance of the nostrils, mouth, pharynx, larynx, oesophagus, rumen (Photo 8.38), omasum, abomasum (Photo 8.39), caecum and, less frequently, in Peyer's patches in the small intestine;
- erythema of the mucosa with submucosal haemorrhage in the abomasum, small intestine, caecum and colon. Striped appearance on the caecal and colon mucosa is similar to that seen in RP;
- cerebral hypoplasia and cataracts in calves.

Judgement:

The carcass and viscera of an animal that on ante-mortem examination shows generalized signs of acute infection accompanied with fever and/or emaciation are condemned. Chronic cases of BVD with no systemic involvement have a favourable judgement of carcass, viscera and organs.

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PHOTO 8.38
BVD: congestion and erosions in the ruminal mucosa

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PHOTO 8.39
BVD: inflammation of the abomasum (abomasitis, gastritis)

Bovine leukosis

Post-mortem findings:

- lymph node enlargement (clay-like consistency);
- enlargement of spleen (splenomegaly);
- thin watery blood;
- neoplastic lesions in the heart (Photo 8.40), intestines (Photo 8.41) (virtually all of the organs may be involved);
- ventral oedema;
- enlarged haemolymph nodes.

Judgement:

The carcass of an animal affected with leukosis (lymphosarcoma) is condemned. When a diagnosis cannot be made by post-mortem findings, a laboratory diagnosis should be performed. If lymph node hyperplasia is the histological diagnosis, the carcass is approved for human consumption. Depending on disease prevalence, leukosis reactors may be totally approved or conditionally approved pending heat treatment.

PHOTO 8.40
Leukosis: neoplastic mass infiltrating the heart muscle

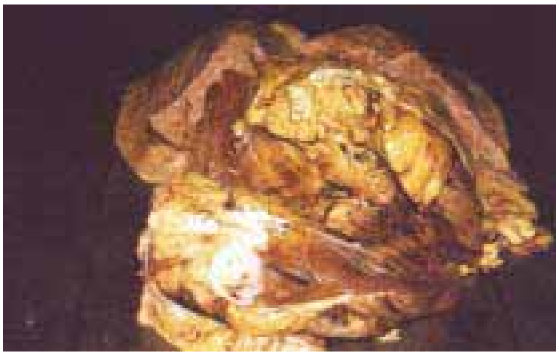

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PHOTO 8.41
Leukosis: neoplastic growths in the intestine - both lesions were histologically confirmed as lymphosarcoma

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DISEASE CAUSED BY PRIONS

Bovine spongiform encephalopathy (BSE, "mad cow disease")

Diagnosis can be confirmed only on the post-mortem histological examination of brain tissue. Microscopic lesions include degenerative lesions in the cerebral cortex (Photo 8.42), medulla and central grey matter of the midbrain.

Judgement:
The carcass is condemned.

Discussion:
Certain tissues or organs in the slaughtered animal are known to present a higher risk than others of containing the infective agent in a BSE-afflicted animal. Of relevance to post-mortem procedures and inspection are the brain and spinal cord, representing the central nervous system, plus the dorsal root ganglia (peripheral nervous system) (Photo 8.43). These have been shown to contain the highest levels of infectivity and their removal from the edible parts of the animal is recommended in countries where BSE is known to occur. Specified risk material (SRM) should be appropriately disposed of (Photo 8.44). The brain is removed as part of

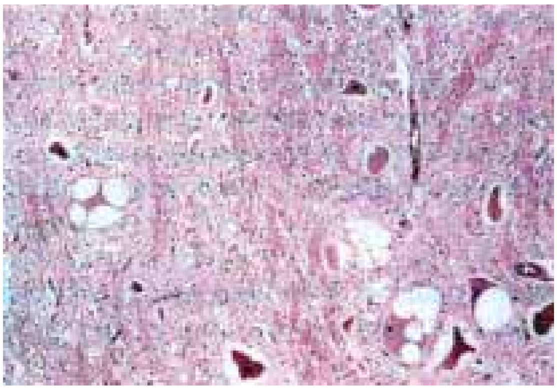

PHOTO 8.42
BSE: degenerative lesions in the cerebral cortex

PHOTO 8.43 ***Sample collection of the brain stem (medulla oblongata)***

PHOTO 8.44
Disposal of specified risk material (SRM)

the head and, following invasive stunning methods such as captive bolt shooting (see also Section 7), contamination of the head is possible so the entire head (apart from the tongue) may be regarded as risk material. Splitting the carcass in the medial plane is necessary in order to remove the spinal cord from the spinal canal (Photo 8.45) but, if this is accomplished by a power saw the cord fragments and some of it is disseminated on the medial surface of the sides, particularly on the dorsal regions, along the vertebral column (Photo 8.46). It is currently not known how much spinal cord remains after carcass jointing and butchery or, therefore, how big a risk this poses to consumers.

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PHOTO 8.45 ***Removal of the spinal cord from the spinal canal***

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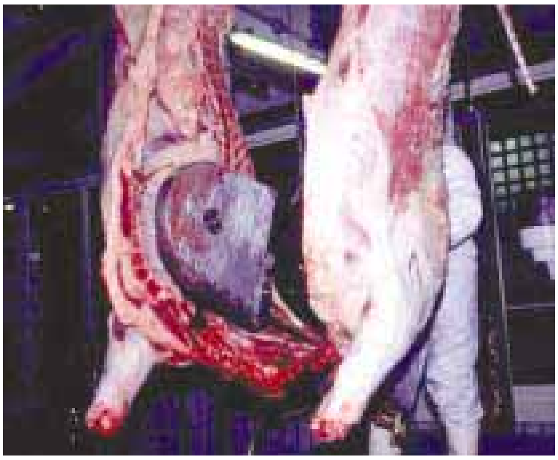

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PHOTO 8.46
Splitting the carcass in the medial plane by power saw

DISEASES CAUSED BY *RICKETTSIA* AND *MYCOPLASMA* SPP.

Heartwater (hydropericardium)

Post-mortem findings:

- hydropericardium;
- hydrothorax;
- pulmonary oedema and ascites;
- haemorrhagic gastro-enteritis;
- enlarged liver, spleen and lymph nodes;
- haemorrhage in the abomasum and intestine;
- oedema and haemorrhage of the brain (Photo 8.47).

Judgement:

The carcass of an animal affected with heartwater is condemned in the acute stage of the disease. In a chronic case, the carcass may be approved if it is adequately bled and the muscles are wholesome in colour and texture. The affected organs are condemned.

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PHOTO 8.47
Heartwater (*Cowdria ruminantium*) in bovine brain smear (arrow)

Contagious bovine pleuropneumonia (CBPP)

Post-mortem findings:

- fibrinous inflammation of the pleura (pleuritis);
- straw-coloured fluid in the thorax (Photo 8.48);
- lobar pneumonia with red hepatization, marbled appearance of lung lobules (Photo 8.49) due to thickening of interlobular septae and interlobular pulmonary oedema;
- enlarged mediastinal lymph nodes;
- walled-off sequestra formation in chronic cases;
- haemorrhage in the heart;
- arthritis and tenosynovitis.

Judgement:

The carcass of an animal affected with CBPP is condemned if the disease is associated with fever, inadequate bleeding of the carcass, serous infiltration of the brisket and emaciation. Recovered animals showing no generalized signs of the disease are approved and the affected organs are condemned.

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PHOTO 8.48
CBPP: straw-coloured fluid in the thorax and partial lung hepatization

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PHOTO 8.49
CBPP: lobar pneumonia with red hepatization and marbled appearance of lung lobules

DISEASES CAUSED BY BACTERIA

Blackquarter (blackleg)

Post-mortem findings:

- lying on one side with affected hind leg stuck out – commonly seen in cattle;
- bloating of carcass and blood-stained frothy exudates from the nostrils and anus;
- dark red to black muscle of the loin, back or leg (Photo 8.50);
- sponge-like bubbly appearance of the muscles with a peculiar rancid odour;
- yellowish, gelatinous subcutaneous tissue and associated gas bubbles;
- blood-stained fluid in body cavities.

Judgement:

The carcass of an animal affected with blackleg should be condemned. It is prohibited to slaughter and dress an animal diagnosed with this disease at ante-mortem examination.

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PHOTO 8.50
Blackleg: dark red skeletal muscle of a heifer showing haemorrhage, necrosis, oedema and emphysema

Botulism

Post-mortem findings:

- foreign material in fore-stomachs or stomachs may be suggestive of botulism.

Judgement:

Total condemnation of the carcass because of human hazards.

Malignant oedema

Post-mortem findings:

- gangrene of the skin in area of infection site;
- foul putrid odour is frequently present;
- gelatinous exudate in the subcutaneous and intramuscular connective tissue;
- subserosal haemorrhage;
- accumulation of sero-sanguineous fluid in body cavities;
- muscle tissue is dark red but has little or no gas.

Judgement:

Carcasses of animals affected with malignant oedema are condemned.

Tuberculosis

Post-mortem findings:

- tuberculous granuloma in the lymph nodes of the head, lungs (Photo 8.51), intestine and carcass;
- these usually have a well defined capsule enclosing a caseous mass with a calcified centre;
- they are usually yellow in colour in cattle, white in buffalo and greyish-white in other animals;
- active lesions may have a reddened periphery and caseous mass in the centre of a lymph node;
- inactive lesions may be calcified and encapsulated;
- nodules on the pleura and peritoneum;
- lesions in the lungs (Photo 8.52), liver, spleen and kidneys;
- bronchopneumonia;
- firmer and enlarged udder, particularly rear quarters;
- lesions in the meninges, bone marrow and joints.

The diagnosis may be confirmed by making a smear of the lesion and staining with Ziehl-Neelsen (carbolfuchsin) reagent. The tuberculosis bacterium is a very small red staining bacillus.

P.G. CHAMBERS, ZIMBABWE

PHOTO 8.51
Tuberculous granuloma in the mediastinal lymph nodes;* Mycobacterium bovis *was isolated

Judgement:

The carcass of an animal affected with tuberculosis requires additional post-mortem examination of the lymph nodes, joints, bones and meninges. It is suggested that the Codex Alimentarius judgement recommendations for cattle and buffalo carcasses be followed.

Carcasses are condemned:

- where an eradication scheme has terminated, or in cases of residual infection or re-infection;
- in the final stages of eradication – where natural prevalence is low;
- during the early stages of eradication in high-prevalence areas.

The carcass of a reactor animal without lesions may be approved for limited distribution. If the economic situation permits, this carcass should be condemned. Heat treatment of meat is suggested during early and final stages of an eradication programme: in low- and high-prevalence areas where one or more organs are affected, and where miliary lesions, signs of generalization or recent haematogenous spread are not observed. If the economic situation permits, then the carcass is condemned.

In some countries, the carcass is approved if inactive lesions (calcified and/or encapsulated) are observed in organs and without generalization in the lymph nodes of the carcass.

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PHOTO 8.52
Lesion of tuberculosis in the lungs

Johne's disease (bovine paratuberculosis)

Post-mortem findings:

- thickened and corrugated intestinal mucosa (Photo 8.53);
- enlarged caecal lymph nodes.

Judgement:
The carcass of an animal affected with Johne's disease is approved when generalized systemic signs of disease are not present. A poor, thin and slightly moist carcass should be held in the chiller and assessed after 24 or 48 hours. If the dryness and setting of the carcass improves during this time it can be released. A carcass with associated oedema and emaciation is condemned.

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PHOTO 8.53
Johne's disease: thickened and corrugated intestinal mucosa

Leptospirosis

Post-mortem findings:

- anaemia and jaundice;
- subserosal and submucosal haemorrhage;
- ulcers and haemorrhages in the abomasal mucosa;
- rarely, pulmonary oedema or emphysema;
- interstitial nephritis (Photo 8.54);
- septicaemia.

Judgement:
The carcass of an animal affected with acute leptospirosis is condemned. A chronic and localized condition may warrant an approval of the carcass.

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PHOTO 8.54
Leptospirosis: interstitial nephritis in a bovine

Brucellosis (contagious abortion, Bang's disease)

Post-mortem findings:

In cattle:

- occasional inflammation of testes and epididymis;
- hygromas on the knees, stifles, hock and angle of the haunch, and between the nuchal ligament and the primary thoracic spines.

In sheep:

- in chronic stage enlarged and hard epididymis, thickened scrotal tunics and frequently atrophic testicles.

Judgement:

Cattle and horse carcasses affected with brucellosis are approved (after removal of the affected parts), as *Brucella* bacteria remain viable in the muscles for only a short period after slaughter. In the acute abortive form (after the miscarriage), cattle carcasses are condemned. Pig, sheep, goat and buffalo carcasses require total condemnation. Heat treatment may be recommended in some areas for these species due to economic reasons. Affected parts of the carcass, udder, genital organs and corresponding lymph nodes must be condemned.

Reactor animals should be carefully handled during slaughter and dressing procedures. Gloves and goggles should be worn when known reactors are being slaughtered and hygroma lesions should be sprayed liberally with 1 percent lactic acid at meat inspection.

Anthrax

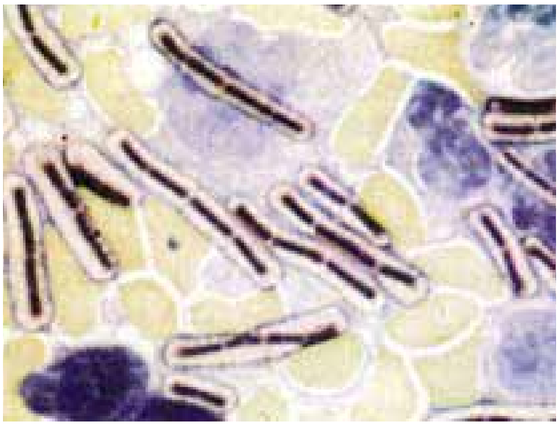
Post-mortem findings:

- dark tarry blood discharge from body orifices;
- absence of rigor mortis;
- haemorrhage of the mucous and serous membranes, lymph nodes and subcutaneous tissue;
- enlarged spleen;
- severe haemorrhagic enteritis;
- degeneration of the liver and kidneys;
- bloating and rapid decomposition of carcass;
- localized lesions in the intestine of pigs (dysentery).

Diagnosis of anthrax is carried out by direct microscopic examination of tissues and fluids (Photo 8.55).

Judgement:

Condemnation of the carcass and its parts by burning or burial. If disposed of by burial, the carcass should be buried at least 2 m below ground. The site should be surrounded by a layer of quicklime 0.30 m thick.



CANADA DEPARTMENT OF AGRICULTURE

PHOTO 8.55

Anthrax:* Bacillus anthracis *in a bovine spleen stained with Toluidine blue; anthrax bacilli in tissue seen in short chains surrounded by a common capsule

Salmonellosis in bovines

Post-mortem findings:

Septicaemic form:

- absence of gross lesions in animals;
- submucosal and subserosal haemorrhage.

Acute enteritis:

- mucoenteritis to diffuse haemorrhagic enteritis;
- severe necrotic enteritis of ileum and large intestine caused by *Salmonella typhimurium*;
- abomasitis in *Salmonella dublin* infection;
- enlarged, oedematous and haemorrhagic lymph nodes;
- thickened inflamed gall bladder wall;
- fatty change of the enlarged liver;
- subserous and epicardial haemorrhage.

Chronic enteritis:

- areas of necrosis in the wall of caecum and colon;
- swollen mesenteric lymph nodes and spleen;
- chronic pneumonia.

In the septicaemic and acute enteric forms, *Salmonella* organisms are present in the blood, liver, bile, spleen, mesenteric lymph nodes and in intestinal content. In the chronic form, bacteria are present in the intestinal lesions and less frequently in other viscera.

Judgement:

A carcass affected with salmonellosis is condemned.

Haemorrhagic septicaemia

Post-mortem findings:

- subcutaneous swellings characterized with yellowish gelatinous fluid, especially around the throat region, brisket and perineum;
- enlarged haemorrhagic lymph nodes;
- haemorrhage in the organs;
- pneumonia (Photo 8.56);
- rarely, haemorrhagic gastro-enteritis;
- petechial haemorrhage in the serous membranes, which is extensive in some cases.

Judgement:

The carcass of an animal affected with haemorrhagic septicaemia is condemned. Dressing of such a carcass would create potential danger for the spread of infection to other carcasses.

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PHOTO 8.56
Haemorrhagic septicaemia: fibrinous bronchopneumonia

Calf diphtheria

Post-mortem findings:

- inflammation and ulceration with large masses of yellow-grey material in the mouth, tongue, pharynx and larynx;
- often, aspiration pneumonia.

Judgement:

The carcass of an animal affected with local lesions is approved. Generalized diphtheric lesions associated with pneumonia or toxaemia require condemnation of the carcass. The carcass is also condemned if lesions are associated with emaciation.

Actinobacillosis (“ wooden tongue”)

Post-mortem findings:

- enlarged tongue showing tough fibrous consistency (wooden tongue) (Photo 8.57);

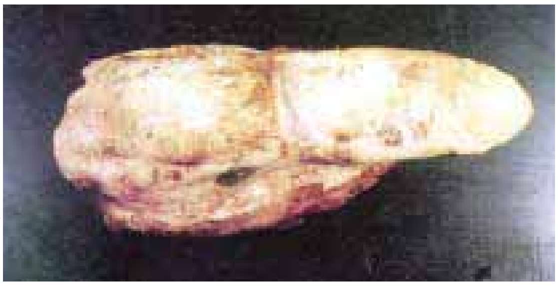

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PHOTO 8.57
Actinobacillosis of the tongue: the tongue is enlarged, firm and contains numerous granulomatous lesions. It is called “ wooden tongue” because of its firmness due to diffuse proliferation of fibrous tissue

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PHOTO 8.58
Actinobacillosis: multifocal, well demarcated yellow lesions in the retropharyngeal lymph node of a bovine animal

- a cluster of small yellowish nodules and erosions of tongue mucosa;
- granulomatous lesions in the lymph nodes (Photo 8.58);
- marked thickening of the lower part of the oesophagus and stomach wall;
- raised plaques and erosions in the mucosa of rumen and reticulum;
- liver and diaphragm lesions due to contact spread from reticulum.

Typical actinobacillosis lesions in the lymph nodes and organs consist of greenish-yellow thick creamy pus with sulphur granules . These are bacterial colonies surrounded by club-like structures.

Judgement:

The carcass of an animal affected with active progressive inflammatory lesions of actinobacillosis in lymph nodes and lung parenchyma is condemned. Condemned material should be sent to an authorized rendering plant. If the disease is slight and confined to lymph nodes, the head and tongue and whole carcass are approved after the condemnation of lymph nodes. If the tongue is diseased and no lymph nodes are involved, the head and carcass are approved. The tongue is condemned.

Actinomycosis (“ lumpy jaw”)

Post-mortem findings:

- lesions in the mandible (lumpy jaw) or maxilla (Photo 8.59);
- granulomatous lesions in the lower part of the oesophagus or anterior part of the reticulum;
- local peritonitis;
- mild abomasitis and enteritis.

Judgement:

See actinobacillosis.

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PHOTO 8.59
Actinomycosis: diffuse granulomas in maxilla and formation of green yellow pus; “ sulphur granules” are found in the pus

Pyelonephritis (contagious bovine pyelonephritis)

Post-mortem findings:

- pyelonephritis showing enlarged, pale and greyish coloured kidney (Photo 8.60) and enlarged renal lymph nodes; purulent lesion in the medulla, pelvis and ureters;
- inflammation of kidney and kidney stones (uroliths) (Photo 8.61);
- enlarged renal lymph nodes;
- uraemia.

Judgement:

Judgement depends on infection of one or both kidneys and/or presence of a urine odour. The carcass of an animal affected with pyelonephritis or nephritis is condemned if: 1) renal insufficiency is associated with uraemia; 2) acute infection of the kidney is accompanied with systemic changes in the organs and lymph nodes, and/or degeneration of body tissues. Borderline cases with uraemic odours should be kept in the chiller for 24 hours. They are subjected to a boiling test. If a urinary odour is not present after detention, the carcass may be approved.

Subacute or chronic kidney infections with no systemic changes allow for a favourable judgement of the carcass. Only the affected parts are condemned. Pyelonephritis associated with kidney stones often has a favourable judgement of the carcass.

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PHOTO 8.60
Pyelonephritis (contagious bovine pyelonephritis): cut section of kidney showing multifocal abscessation in the cortex and medulla

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PHOTO 8.61
Pyelonephritis associated with urolithiasis (stones); chemical analysis revealed oxalate composition

Metritis

Post-mortem findings:

- enlarged flaccid uterus showing paintbrush haemorrhages on the serosal surface;
- inflammation of the uterus with light brown foul-smelling uterine exudate (Photo 8.62);
- enlarged uterus containing greenish-yellow purulent exudate (pyometra, Photo 8.63);
- inflamed peritoneum at the entrance of the pelvic cavity;
- enlarged iliac, lumbar and sacral lymph nodes;
- degeneration of the liver, kidney and heart muscles may be present;
- congested musculature of the carcass;
- necrosis of abdominal fat.

Judgement:

The carcass of an animal affected with acute metritis is condemned if it is associated with septicaemia or toxaemia. In chronic cases, when toxaemic signs are lacking, the carcass may be approved if no antibiotic residues are found.

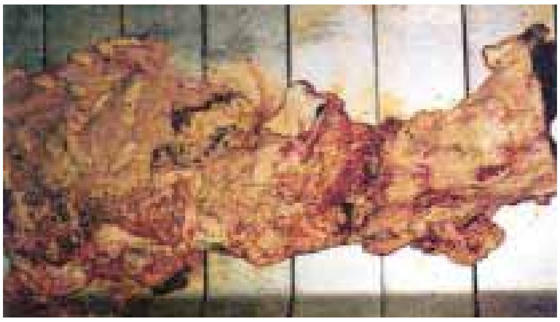

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PHOTO 8.62

Metritis: necrotizing inflammation of the uterus with light brown foul-smelling uterine exudate

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PHOTO 8.63

Pyometra: enlarged uterus containing greenish-yellow exudate

Mastitis

Post-mortem findings:

- pale yellow granular appearance of the udder parenchyma (Photo 8.64);
- light brown oedematous udder parenchyma (Photo 8.65);
- enlarged supramammary, iliac and lumbar lymph nodes;
- injection sites.

Judgement:

The carcass and viscera are condemned if acute or gangrenous mastitis is associated with systemic changes. If infection has spread from the supramammary lymph nodes via the iliac lymph nodes to the lumbar lymph nodes, this can be taken as evidence of spread of infection from its primary location. The condemnation of the carcass may then be warranted. A localized condition of the udder has a favourable judgement of the carcass.

PHOTO 8.64

Chronic mastitis: enlarged, firm udder. Incision into the udder parenchyma shows normal milk and pale yellow granular appearance of the udder parenchyma

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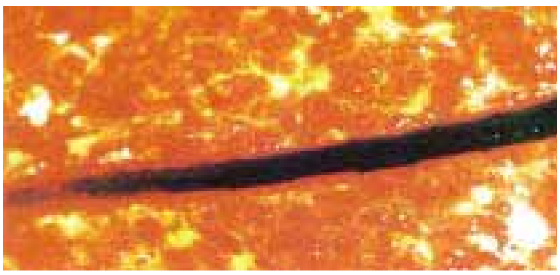

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PHOTO 8.65

***Brownish-red oedematous udder parenchyma. The udder culture resulted in a heavy growth of* Staphylococcus aureus**

Endocarditis

Post-mortem findings:

- large cauliflower-like lesions (Photo 8.66) in the endocardium;
- small wart-like and verrucose lesions in the endocardium;
- embolic lesions in other organs including the lungs, spleen and kidneys.

PHOTO 8.66
Endocarditis: vegetative valvular endocarditis

Judgement:

The carcass of a debilitated animal is condemned for verrucose endocarditis if it is associated with lesions in the lungs, liver or kidneys. A carcass affected with ulcerative or verrucose endocarditis with no signs of systemic changes and negative bacteriological result may be approved after heat treatment is applied. Endocarditis showing scar tissue is approved. The heart is condemned.

Traumatic reticuloperitonitis (TRP, hardware disease, traumatic gastritis, traumatic reticulitis)

Post-mortem findings:

- adhesions of rumen, reticulum and peritoneum and abscessation;
- acute or chronic peritonitis;
- splenic abscessation;
- traumatic pericarditis (Photo 8.67);
- metallic objects such as nails, pieces of wire or magnets in the reticulum;
- lung abscessation or pneumonia;
- septic pleuritis;
- oedema of the chest.

Judgement:

The viscera and carcass are condemned:

- if the animal is affected with acute diffuse peritonitis or acute infectious pericarditis associated with septicaemia;
- if the carcass has traumatic pericarditis associated with fever, large accumulation of exudate, circulatory disturbances, degenerative changes in organs, or abnormal odour;
- if the carcass has chronic traumatic reticulo-peritonitis and/or purulent pericarditis with associated pleuritis, abscessation and oedema of the chest.

Chronic adhesive localized peritonitis and chronic pericarditis without systemic changes in well nourished animals allow a favourable judgement of the carcass. The affected parts of the carcass and organs are condemned.

A carcass affected with infectious exudative pericarditis in a subacute stage may be conditionally approved pending heat treatment, if bacteriological and antibiotic residue findings are negative.

PHOTO 8.67
TRP: cross-section of the heart reveals thick fibrinous deposits that encircle the heart. In this case a rusty nail has penetrated through the wall of the reticulum into the pericardium

PARASITIC DISEASES

■ Diseases caused by helminths ■

Lungworms

Post-mortem findings:

- haemorrhagic inflammation of bronchi with froth;
- lung oedema and emphysema;
- consolidation of lung parenchyma;
- lungworms;
- enlarged lung lymph nodes.

Judgement :

Carcass of animal affected with lungworms is approved if infestation is slight and no secondary changes are observed. The lungs are condemned. The carcass is condemned if lungworm infestation has caused pneumonia which is accompanied with emaciation or anaemia.

Fascioliasis

Post-mortem findings:

- emaciated, anaemic or oedematous carcass in severe chronic infestations;
- presence of flukes in enlarged and thickened bile ducts and in the liver parenchyma;
- hepatic abscesses and secondary bacterial infection;
- calcification of bile ducts;
- black parasitic material (excrement) in the liver, lungs, diaphragm and peritoneum;
- haemorrhagic tracts of migratory immature flukes in the lungs and liver in an acute infestation (Photo 8.68);
- black lymph nodes of the lungs and liver due to fluke excrement;
- icterus due to liver damage.

PHOTO 8.68
Acute haemorrhagic tract in a bovine liver

P.G. CHAMBERS, ZIMBABWE

Judgement:

Judgement depends on the extent of the fluke lesions and the condition of the carcass. Severe infestation with associated emaciation or oedema would necessitate total condemnation of the carcass. Mild, moderate and heavy infestation without emaciation may have a favourable judgement. If the parasitic lesions in the liver are clearly circumscribed, the liver may be salvaged after trimming of affected tissue. Otherwise it is condemned.

Oesophagostomiasis (pimply gut, nodular worms)

Post-mortem findings:

- greyish-white nodules ranging in size from a pinhead to a pea (Photo 8.69); the nodules may contain a greenish pasty material in younger lesions or a yellow-brown crumbly material in older lesions;
- thickening of the intestinal wall;
- local peritonitis;
- mild inflammation of the intestine in the acute stage;
- chronic inflammation of the colon in the chronic stage.

Judgement:

Intestines affected with nodular worms are condemned. The carcass is also condemned if severe infestation of this parasite is associated with emaciation and oedema. Mild, moderate and heavy infestation without emaciation may have a favourable judgement. However, intestines should always be condemned as they cannot be used for sausage manufacture.

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PHOTO 8.69
Oesophagostomiasis: parasitic nodules on the intestinal mucosa (top) and serosa (bottom) in a young bovine animal

Cysticercosis

Post-mortem findings:

- small white lesions (cysticerci two to three weeks after infection) in muscle tissue;
- clear transparent bladders 5 mm x 10 mm (infective cysticerci, 12–15 weeks after infection) (Photo 8.70);
- opaque and pearl-like cysts (over 15 weeks of infection);
- degeneration, caseation and calcification of the cysts (after 12 months or more after infection);
- degenerative myocarditis.

PHOTO 8.70
Caseous cysticercus: ***numerous clear transparent cysts 0.6 mm in diameter in the heart muscle***

P.G. CHAMBERS, ZIMBABWE

Judgement:

The carcass and viscera of an infested animal should be differentiated between those with heavy infestation and those with light infestation. The carcass and viscera of heavily infested animals are condemned and those with light infestations should be treated either by boiling or freezing. The extent of heavy infestation is prescribed by the controlling authority. An animal is commonly considered heavily infected if lesions are discovered in two of the usual inspection sites, including the masseter muscles, tongue, oesophagus, heart, diaphragm or exposed musculature, and in two sites during incisions into the shoulder and into the rounds. Generalized infection according to Canadian regulations means two or three cysts found on each cut into the muscles of mastication, heart, diaphragm and its pillars, and also if two or three cysts are found in muscles exposed during dressing procedures. In moderate or light infestation consisting of a small number of dead or degenerated cysticerci, the carcass is held depending on the existing country regulations for approximately 10 days at -10 C.

Hydatid disease (hydatidosis, echinococcosis)

Post-mortem findings:

Hydatid cysts are found in:

- the liver (Photo 8.71), heart (Photo 8.72), lungs, spleen, kidneys;
- muscle and brain;
- any tissue including bone.

Judgement:

Carcass showing emaciation, oedema and muscular involvement is condemned and destroyed. Otherwise the carcass is approved. Affected viscera and any other tissue are also condemned and destroyed. Burying the carcass is not sufficient, since dogs may retrieve the affected organs.

P. SENEVIRATNA, AUSTRALIA

PHOTO 8.71
Hydatid cysts in a bovine liver

P.G. CHAMBERS, ZIMBABWE

PHOTO 8.72
Hydatid cysts in a bovine heart; note the detached germinal layer

Onchocercosis

Post-mortem findings:

- firm fibrous nodules (0.5–5.0 cm in diameter) singly or in clusters in the regions of the brisket (Photo 8.73), buttocks and thighs;
- the nodules have tightly coiled worms;
- the worms may be dead or calcified in older nodules.

Judgement:

The affected carcasses can be passed after the nodules have been removed. In heavy infestations the affected briskets are removed, and the tissue and the fascia around the stifle and the brisket are stripped off before the carcasses are passed.

P. SENEVIRATNA, AUSTRALIA

PHOTO 8.73
Firm fibrous nodules of* Onchocerca gibsoni *in the brisket of an ox

PARASITIC DISEASES

■ Diseases caused by protozoa ■

Trypanosomiasis

Post-mortem findings:
- enlarged lymph nodes;
- enlargement of the spleen, liver and kidneys may also occur;
- oedematous and emaciated carcass;
- mild icterus.

Judgement :
The carcass affected with trypanosomiasis or any other protozoan diseases is condemned if an acute condition is associated with systemic body changes. Heat treatment may be recommended in some cases if economically feasible. The carcass of recovered and reactor animals may be approved if generalized lesions are lacking.

A carcass showing borderline emaciation or slight oedema should be examined after 24–48 hours in the chiller. A satisfactory setting would lead to a favourable judgement of the carcass. The affected parts of the carcass and organs are condemned.

Theileriosis (East Coast fever)

Post-mortem findings:
- froth in nostrils and bronchi associated with pulmonary oedema and emphysema;
- swollen, oedematous lungs and interstitial pneumonia (Photo 8.74);
- enlarged and haemorrhagic lymph nodes and splenic lymphoid hypertrophy;
- enlarged and mottled liver;
- infarcts, thrombosis and lymphoid hypertrophy in spleen (Photo 8.75);
- white spots of lymphoid aggregates in the kidneys;
- brownish coloration of fat;
- haemorrhagic and, rarely, ulcerative enteritis.

Confirmation of diagnosis is only made through detection of parasites in a Giemsa-stained lymph node biopsy smear and/or blood smear.

Judgement:
Carcass and viscera of an animal affected with febrile chronic theileriosis and without systemic lesions are approved. Carcass is condemned if acute febrile theileriosis is accompanied with fever and generalized lesions. The affected organs are also condemned.

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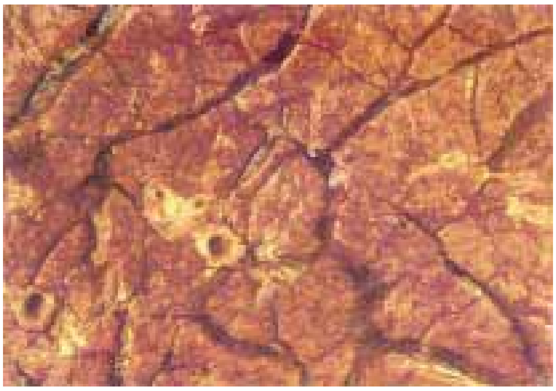

PHOTO 8.74
Theileriosis: swollen oedematous lungs and interstitial pneumonia

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PHOTO 8.75
Theileriosis: infarcts, thrombosis and lymphoid hypertrophy in spleen

Besnoitiosis

Post-mortem findings:

- inflammation of the pharynx, larynx and trachea;
- sand-like granules and cysts in the turbinates and nostrils (Photo 8.76);
- sand-like granules in the endothelium of large vessels;
- dermatitis.

Judgement :

The carcass is approved if the lesions are localized with no systemic involvement. Carcass is condemned if disseminated, generalized lesions are accompanied with emaciation.

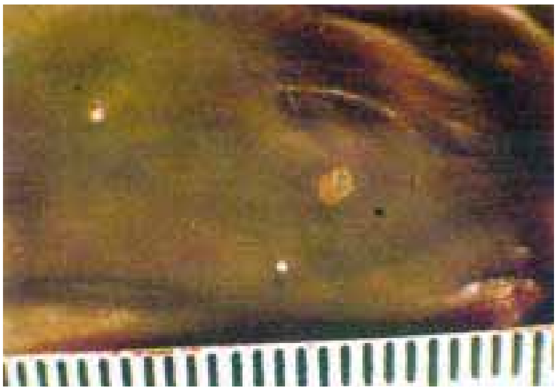

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PHOTO 8.76

Besnoitiosis: sand-like granules and cysts in the nostrils of an antelope

Anaplasmosis (gall sickness)

Post-mortem findings:

- enlarged and congested spleen (splenomegaly) showing soft pulp;
- distended gall bladder with dark tarry bile;
- thin, watery blood, which clots poorly;
- enlarged, icteric liver, deep orange in colour and distended bile ducts (Photo 8.77);
- lemon yellow carcass and connective tissue of the sclera of the eye, tendons, pleura, peritoneum and attachments of the diaphragm.

Diagnosis can only be confirmed by detecting parasites in a blood smear stained with Giemsa.

Judgement:

Carcass of an animal showing acute infection should be condemned. Recovered and suspect animals manifesting inconclusive signs of anaplasmosis are approved if otherwise healthy. A mildly yellow discoloured carcass may be chilled and assessed after setting. If the discoloration has disappeared, the carcass is approved. Animals affected with anaplasmosis could be treated under the supervision of a government official. Guidelines for the withdrawal period for therapeutic agents should be followed if the animals are being shipped for slaughter.

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PHOTO 8.77

Anaplasmosis: ox liver affected with disease showing distended bile ducts

Babesiosis (piroplasmosis, Texas fever, red water fever, tick fever)

Post-mortem findings:

- oedema and congested lungs;
- enlarged and yellow liver and distended gall bladder with thick dark green bile;
- enlarged spleen;
- anaemia and pale muscles;
- jaundice particularly noted in the connective tissue;
- oedematous and haemorrhagic lymph nodes;
- yellowish-orange colour of musculature (mild cases);
- occasionally dark kidneys with no other findings;
- pink haemorrhage of a bovine brain (Photo 8.78).

Diagnosis can only be confirmed by identification of the parasite in the peripheral blood smear stained with Giemsa (Photo 8.79).

Judgement :

The carcass of an animal with the acute form of the disease, with associated icterus, is condemned. An emaciated, jaundiced carcass showing yellow gelatinous fat also requires total condemnation. A mild form of this disease showing yellow-orange coloration of the carcass, not associated with icterus, may be approved. The satisfactory setting of the carcass in the chiller must be considered in this approval.

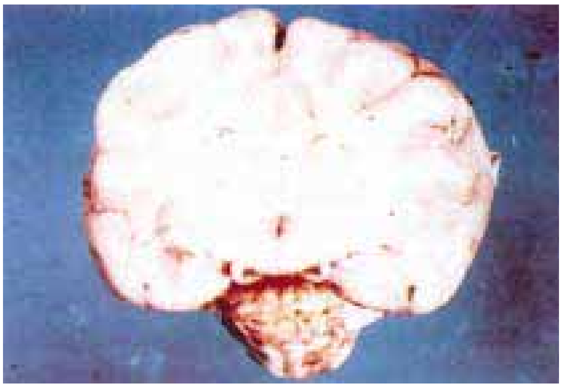


PHOTO 8.78
Pink haemorrhage: cerebral form of babesiosis caused by* Babesia bovis*; it is characterized by formation of thrombi and emboli in brain capillaries

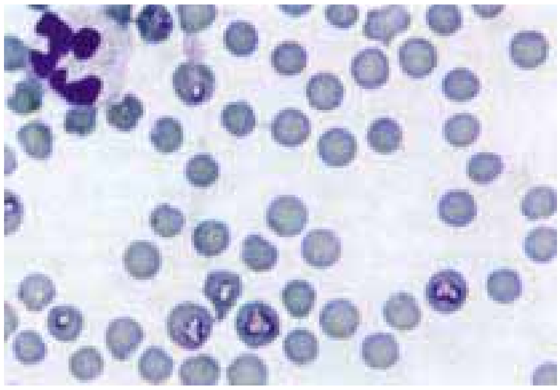


PHOTO 8.79
Babesia bigemina *in American bison blood*

Sarcocystosis (sarcosporidiosis)

Post-mortem findings:

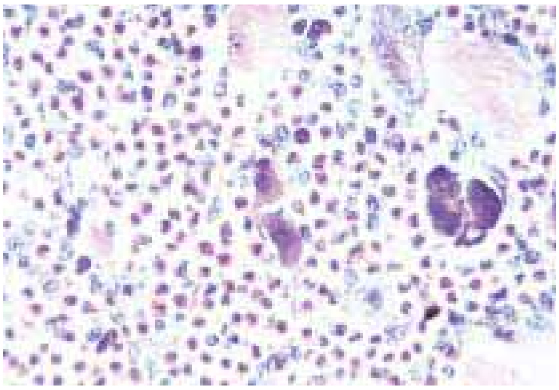
- the cysts are microscopic and therefore are not detected on routine post-mortem inspection;
- the cysts cause little tissue reaction;
- in some cases the cysts may be associated with eosinophilic myositis (Photo 8.80);
- histological section of bovine muscle shows massive accumulation of eosinophiles and microcysts of *Sarcocystis cruzi* (Photo 8.81);
- *S. hirsuta* cysts may be seen as fusiform objects 8 mm x 1 mm in the oesophagus, diaphragm and skeletal muscles of older animals, especially bulls;
- macroscopic cysts of *S. fusiformis* in the skeletal muscle of buffalo (Photo 8.82).

Judgement:

Judgement should be made on macroscopic presence of cysts. In heavy and widespread infestations with visible cysts the whole carcass is condemned. In lighter infestations those parts of the carcass that are not affected are passed for human consumption.

D. HERENDA, CANADA

PHOTO 8.80
Sarcocystosis: eosinophilic myositis



P. SENEVIRATNA, AUSTRALIA

PHOTO 8.81
Sarcocystosis: histological section showing accumulation of eosinophiles and two microcysts of* S. cruzi*; there is no tissue reaction

P.G. CHAMBERS, ZIMBABWE

PHOTO 8.82
S. fusiformis *in the skeletal musculature of buffalo*

PARASITIC DISEASES

■ Diseases caused by arthropod parasites ■

Hypoderma bovis infestation

Post-mortem findings:

- inflamed area of subcutaneous tissue, red, green or yellow in colour, around the maggot or at the site where the maggot lodged;
- inflammation of the oesophagus, which may cause rumen bloat due to obstruction;
- *Hypoderma bovis* larvae (Photo 8.83).

Judgement:

Carcass of an animal affected with *Hypoderma bovis* is approved. Subcutaneous lesions are removed.

MOSBY YEAR-BOOK INC., USA

PHOTO 8.83
Hypoderma bovis *larvae*

Screwworm myiasis

Post-mortem findings:

After five to seven days of infestation, a wound may be expanded to 3 cm or more in diameter and 5–20 cm deep with larvae from a single screwworm egg mass. Usually by this stage, additional screwworm flies have deposited eggs, resulting in a multiple infestation. However, after death the larvae leave the body as a result of the temperature reduction and some third-stage instar larvae may pupate in the body.

Judgement:

The affected carcass can be passed after the wound tissues have been removed and incinerated.

SECTION 9

Hygiene, dressing and carcass handling

During initial dressing operations, and with due consideration to minimizing contamination:

- slaughtered animals that are scalded, flamed or similarly treated should be scoured of all bristles, hair, scurf, feathers, cuticles and dirt;
- the trachea and oesophagus should remain intact during bleeding, except in the case of ritual slaughter;
- bleeding should be as complete as possible; if blood is intended for food, it should be collected and handled in a hygienic manner;
- exposure of the tongue should be done in such a way that the tonsils are not cut;
- skinning of the head may not be required for some classes of animals, e.g. goats, calves, sheep, provided that heads are handled in such a way as to avoid undue contamination of meat;
- before the removal from the head of any parts intended for human consumption, the head should be clean and, except in the case of scalded and dehaired carcasses, skinned to an extent sufficient to facilitate inspection and the hygienic removal of specified parts;
- lactating or obviously diseased udders should be removed from carcasses at the earliest opportunity;
- removal of udders should be done in such as way that the contents do not contaminate the carcass;
- gas skinning or dehiding (pumping of air or gas between the skin or hide and the underlying tissue to facilitate skinning) should only be permitted if it can be achieved with minimal contamination and meets required microbiological and organoleptic performance criteria; and
- hides/fleeces should not be washed, de-fleshed or left to accumulate in any part of an abattoir or establishment that is used for slaughter or dressing.

Source: FAO/WHO.

MEATCOPHOTOS

INTRODUCTION

The hide/skin and viscera of animals entering a slaughter facility are potential sources of contamination of carcasses with pathogenic bacteria. The major objectives in hygienic dressing and carcass handling are thus to:

- prevent contamination of the edible portions of the carcass with soiling material from the hides, skins and pelts, and from the contents of the internal organs;
- inhibit microbial growth on the surfaces of carcasses or meat;
- eliminate any carcasses or portions of carcass that are deemed unsuitable for human consumption.

If evisceration is correctly performed, visceral contents are not a significant source of carcass contamination. However, transfer of contamination from the hides to the carcass surface is effectively unavoidable due to the nature of the removal processes. One way of minimizing this source of contamination is by ensuring that all animals that enter the slaughter floor have undergone ante-mortem inspection and have been passed as suitable for slaughter. Thereafter, rigorous measures should be taken to prevent the direct transfer (i.e. contact between the hide and the carcass) and indirect transfer (e.g. from workers' hands, clothes, tools and equipment) of contamination from the hide to the carcass.

The principles of hygienic practice for dressing and carcass handling of red meat animals (cattle/large ruminants, sheep/small ruminants and pigs) are similar for all these species. Therefore, the principles will be outlined for cattle, while for other species only those specific aspects that differ from cattle will be indicated.

GENERAL REQUIREMENTS

Basic equipment required for slaughter and dressing

Slaughtering equipment, particularly for small-scale operations, need not be elaborate and expensive. The amount of equipment will depend on the slaughtering procedures employed. If possible, all equipment should be made of stainless steel or plastic, be rust-resistant and easily cleaned and sanitized. Equipment that does come into in contact with the meat (e.g. overhead rails, working platforms, stunning pens) is usually made of galvanized steel.

The basic equipment that is needed for the slaughtering operation consists of:

- stunning gun, electrical head tongs or simple stunning equipment for direct blow;
- knives:
  - sticking: 16 cm sharpened on both sides;
  - skinning: 16 cm curved;
- a sharpening steel;
- oil or water sharpening stone;
- scabbard and belt for holding knives;
- meat saw (hand or electric) and cleaver;
- block and tackle or chain hoist strong enough to hold the weight of the animal to be slaughtered;
- pritch, chocks or skinning rack (dressing cradle);
- a strong beam, tripod or track 2.4–3.4 m from the floor;
- spreader – gambrel or metal pipe;
- several buckets;
- working platforms.

The following items are additional equipment required when pigs are scalded and scraped rather than skinned:

- scalding barrel or tank;
- pot, barrel or system for boiling water;
- bell scrapers;
- solid scraping table or platform;
- thermometer registering up to 70 C
- hog or hay hook;
- torch or flame for singeing.

Other useful additional equipment includes:

- stunning pen;
- bleeding hooks (for vertical bleeding);
- blood-catching trough;
- wash trough (for tripe).

The following items are necessary for sanitation of hands and tools:

- hand wash-basin;
- implement sterilizers.

There should be provisions for thoroughly cleaning all equipment coming into contact with carcasses or meat. Implement sterilizers are stainless-steel boxes holding hot (82 C) water, shaped to suit particular equipment (i.e. knives, cleavers, saws, etc.). Knife sterilizers should be positioned where every operator who uses a knife has immediate access. Handles as well as blades must be sterilized. Each operator should have at least two knives or other equipment (e.g. flay masters, anchoring chains, kidney enucleators), one to use while the other sterilizes. Failure to sterilize all knives and equipment regularly will result in carcass contamination. Bacteria will be transferred from the hide to the carcass and from carcass to carcass.

Personnel

Workers should wear protective clothing of the type and colour approved by the competent authority. The clothing should be kept clean at all times; otherwise it should be changed on a regular basis. Damaged clothing should be replaced. Aprons, protective sleeves, gloves, boots, knives, steels and scabbards should be clean at the start of breaks and at the beginning of every work period.

Workers should wash their hands and arms whenever they contact contaminated items/surfaces or otherwise on a regular basis, at the start of work and after every break. Workers who handle both external hide/pelt surfaces and exposed products should wash their hands before touching exposed carcass surfaces. Movement of workers between clean and dirty areas of the abattoirs should be restricted.

Hygienic dressing of cattle

The outer side of the hide must never touch the skinned surface of the carcass. As little blood as possible should come into contact with the hide or skin. Operators must not touch the skinned surface with the hand that was in contact with the skin.

Combined horizontal/vertical methods

Head. After bleeding, while the animal is still hanging from the shackling chain, the horns are removed and the head is skinned. The head is detached by cutting through the neck muscles and the occipital joint, and hung on a hook. The head should be identifiable as part of the carcass from which it was detached for post-mortem inspection. The carcass is then lowered on its back into the dressing cradle.

Legs. Skin and remove the legs at the carpal (foreleg) and tarsal (hind leg) joints. The forelegs should not be skinned or removed before the carcass is lowered on to the dressing cradle or the cut surfaces will be contaminated. The hooves may be left attached to the hide.

Flaying. Cut the skin along the middle line from the sticking wound to the tail. Using long firm strokes and, keeping the knife up to prevent knife cuts on the carcass, skin the brisket and flanks, working backwards towards the round. Skin udders without puncturing the glandular tissue and remove, leaving the supermammary glands intact and attached to the carcass. At this point raise the carcass to the half-hoist position, the shoulders resting on the cradle and the rump at a good working height.

Clear the skin carefully from around the vent (anus) without puncturing it and cut the abdominal wall carefully around the rectum. Tie off the rectum with twine to seal it. Skin the tail avoiding contamination of the skinned surface with the hide. Raise the carcass free of the floor and finish flaying.

Vertical methods

High-throughput plants have overhead rails that convey the carcass from the sticking point to the chills. Hide removal is carried out on the hanging carcass. The operations are as in the combined horizontal/vertical method, but as it is not possible to reach the hide from ground level, more than one operator is needed. A single operator may work with a hydraulic platform that is raised and lowered as required.

Automatic hide-pullers are used in high-throughput slaughterhouses. Some types pull the hide down from the hind end, others from the shoulders upwards towards the rump.

Automation of hide removal reduces contamination since there is less handling of the carcass and less use of knives. Moving overhead rails also improve hygiene by reducing carcass contact with operators, equipment such as dressing cradles and with each other, since carcasses are evenly spaced.

Hygienic dressing of small ruminants

Sheep fleeces can carry large volumes of dirt and faeces into the slaughterhouse. It is impossible to avoid contamination of sheep and lamb carcasses when the fleece is heavily soiled. Therefore heavily soiled animals should be screened out during ante-mortem inspection and appropriate action taken (e.g. they should be slaughtered at the end of the slaughter line with more precautions taken to prevent carcass contamination; see Section 6). The fleece or hair must never touch the skinned surface. Neither must the operator touch the skinned surface with the hand that was in contact with the fleece/hair.

Combined horizontal/vertical method

The animal is turned on its back and cuts are made from the knuckles down the forelegs. The neck, cheeks and shoulders are skinned. The throat is opened up and the oesophagus is tied off. The skin on the hind legs is cut from the knuckles down to the tail root. The legs are skinned and the sheep is hoisted by a gambrel inserted into the Achilles tendons. A rip is made down the midline and skinning proceeds over the flanks using special knives or the fists (punching out). The pelt is then pulled down over the backbone to the head. If the head is for human consumption it must be skinned or it will be contaminated with blood, dirt and hairs.

Moving cratch and rail system

The hanging carcass is lowered on to a horizontal conveyor made up of a series of horizontal steel plates, bowed slightly and divided into sets large enough to cradle a single animal. Two operators usually work together on each lamb performing the legging operations and opening the skin to the stage where it can be pulled off the back. When the gambrel is inserted into the hind legs, it is hoisted onto a dressing rail.

Vertical method

At sticking the animal is shackled by one hind leg and left to bleed. Dressing commences with the free leg, which is skinned, and the foot removed. A gambrel is inserted into this leg and hung on a runner on a dressing rail. The second leg is freed from the shackle, skinned and dressed, then hooked on to the other end of the gambrel. The skin is opened down the midline and cleared from the rump.

A spreader frame (a bar that is U-shaped at each end) spreads the front legs to simplify work on the neck, breast and flanks. The front feet are held in each end of the frame, which is then slung up on to a separate travelling hook. The animal is therefore suspended by all four legs, belly uppermost. Skinning continues as in the combined horizontal/vertical method. To clear the shoulders and flanks, the forelegs are freed from the spreader and the feet removed, the animal returning to a vertical position. The skin

BOX 9.1 **Good hygienic practice for skinning of ruminants (traditional, combined horizontal/vertical methods*)**

The following good hygienic practice (GHP) principles should apply to all skinning methods and stages:

- Prevent contact (in-rolling) or dirt flicking from freed parts of the hide and the meat surface.
- Do not touch the meat surface or the knife with the hand that held the hide (i.e. do not alternate hide- and knife-holding hands) before effective hand-washing.
- Prevent contamination of the carcass with dirty hooks, rollers and protective clothing.
- After the initial cut through the skin, sterilize the knife in water at 82 °C, and then make all other cuts from the inside out (" spear-cuts").
- Do not create aerosols during mechanical hide-pulling.
- No hair or skin pieces should be left on the skinned carcass.
- No excess blood should appear on the skin of the carcass.

* In some larger abattoirs, more automated methods are used. The skinning principles are the same, but some differences include:
  - The carcasses hang from rails (no cradles) and are conveyed through the dressing operation.
  - A single operator standing on a hydraulic platform may skin the whole carcass.
  - Mechanical hide-pullers remove the hide after initial manual skinning.
  - Less manual handling results in improved carcass hygiene.

can now be completely pulled off. The head is also skinned if it is meant for consumption, though this takes some work with the knife. In both methods, after removal of the fleece the vent and oesophagus are cleaned and tied off.

Table 9.1 summarizes the steps in carcass skinning, along with the major points of hygiene that should be focused on.

Specific details related to hygiene of slaughter and dressing of pigs

Scalding of pigs

- Ensure pigs are dead before scalding.
- Ensure the scalding water is around 60 C and that it is changed as frequently as required to avoid excessively dirty water contributing to carcass contamination.
- The scalding should last around six minutes to loosen the hair sufficiently.
- Scalding can be carried out using a water tank, or vertically using a hot-water shower (the latter is more hygienic, but more expensive).

Dehairing of pigs

- Dehairing can be done manually using a specially shaped scraper.
- Dehairing can also be done using a special machine with rotating rubber-tipped paddles.
- In some abattoirs, scalding and scraping can be combined and done within the scalding tank.
- Dehairing can also be done by dipping pigs in a melted resin (re-usable), and removing the solidified resin layer together with the hairs.

Singeing of pigs

After scalding, burn the remaining hair on the skin with a hand-held gas torch. In larger abattoirs, this can be done using a furnace. After singeing, the black deposits and ash have to be

TABLE 9.1 **Skinning**

Main steps	Stages	Pay attention to:
Skinning and removal of head while the animal is hanging	Remove the horns. Skin the head. Detach the head through occipital joint. Tie the oesophagus.	GHP Hook up the head.
Removal of hind legs	Skin and detach the hind legs through tarsal joint.	GHP
Lowering the carcass to horizontal position	Place the carcass on its back, on to cradle.	GHP
Removal of forelegs	Skin and detach forelegs through carpal joint.	GHP
Flaying on cradle	Cut the skin along the middle line from the sticking wound to the tail. Skin the brisket and flanks. Skin/remove the udder.	GHP Do not puncture the udder (mastitis pathogens!). Leave supermammary glands on carcass intact.
Flaying in half-vertical position	Raise the carcass to half-hoist. Clear the skin around anus. Cut abdominal wall around rectum. Tie-off the rectum with twine/cover with plastic bag. Skin the tail.	GHP Do not puncture the anus/rectum (enteric pathogens!).
Flaying in vertical position	Raise the carcass free of cradle/floor. Skin the back and complete flaying.	GHP

scraped off (polishing) and the carcass cleaned thoroughly. The scraping equipment (scrapers, brushes) must be regularly cleaned as it may serve as a carcass re-contamination source.

Skinning of pigs

If the pigskin is to be used by the leather industry, pigs can be skinned instead of scalded. In this case the hygienic principles described for cattle are applied.

Evisceration

With all species, care must be taken in all operations not to puncture any organs such as the viscera, urinary bladder, gall bladder or uterus. If this happens, the contaminated portion of the carcass must be cut off. All viscera must be identified with the carcass until the veterinary inspection has been passed. After inspection the viscera should be chilled on racks, etc. for better air circulation.

It is of utmost importance that hands be washed regularly during evisceration. All knives and saws used during this process must be sterilized regularly and must never be put down on the floor.

Facilities should be provided for eviscerators to do their job hygienically. In the case of a mechanical conveyor belt, boot-washing, apron-washing and other washing/sterilizing facilities must be made available. In smaller abattoirs a hand-basin/sterilizer must be provided. In all cases, there should be facilities for sterilizing the evisceration platform and the offal containers.

Cattle

The brisket is sawn down the middle. In the combined horizontal/vertical system this is done with the animal resting on the cradle. The carcass is then raised to the half-hoist position and, when hide removal is complete, the abdominal cavity is cut carefully along the middle line. The carcass is then fully hoisted to hang clear of the floor so that the viscera fall out under their own weight. They are separated into thoracic viscera, paunch and intestines for inspection and cleaning. If any of the stomachs or intestines are to be saved for human consumption, then the oesophagus/stomach and stomach/duodenum boundaries should be tied (the oesophagus and rectum having been tied off during hide removal). This prevents cross-contamination between the paunch and the intestines.

Small ruminants

A small cut is made in the abdominal cavity wall just above the brisket, and the fingers of the other hand are inserted to lift the body wall away from the viscera as the cut is continued to within about 5 cm of the cod fat or udder.

The omentum is withdrawn, the (tied-off) rectum is loosened, and the viscera are freed and taken out. The (tied-off) oesophagus is pulled up through the diaphragm. The breastbone is split down the middle taking care not to puncture the thoracic organs, which are then removed.

BOX 9.2 **GHP for evisceration (traditional, combined horizontal/vertical methods*)**

The following GHP principles should be applied in all evisceration methods and stages:

- Do not puncture the viscera.
- Prevent leakages from the viscera (alimentary tract), uterus, urinary bladder and gall bladder during separation cuts.
- Prevent contact of viscera with floors/walls.
- Regularly wash hands/aprons and sterilize knives.
- Identify/correlate viscera with the related carcasses.

* In larger abattoirs, where the carcasses hang from rails (no cradles) and are conveyed through the dressing operation, the whole evisceration is conducted in a vertical position.

Pigs

Loosen and tie off the rectum. Cut along the middle line through the skin and body wall from the crotch to the neck. Cut through the pelvis and remove the bladder and sexual organs. In males the foreskin must not be punctured as the contents are a serious source of contamination. All these organs are considered inedible. Remove the abdominal and thoracic viscera intact. Avoid contact with the floor or standing platform. The kidneys are usually removed after the carcass has been split down the backbone. The head is usually left on until after chilling.

Table 9.2 summarizes the steps in evisceration, along with the major points of hygiene to focus on.

SPLITTING, WASHING AND TRIMMING OF CARCASSES

Carcass splitting

Cattle

Work facing the back of the carcass. Split the carcass down the backbone (chine) with a saw or cleaver from the pelvis to the neck. Sawing gives a better result but bone dust must be removed. If a cleaver is used, it may be necessary to saw through the rump and loin in older animals.

The saw and cleaver should be sterilized in hot (82 C) water between carcasses. Power saws increase productivity.

Pigs

These are suspended and are split down the backbone as for cattle, but the head is generally left intact.

Sheep

Sheep and lamb carcasses are generally sold whole. If necessary they can be split by saw or cleaver, but a saw will probably be necessary for older animals.

Carcass trimming

The object of carcass trimming is to remove all damaged or contaminated parts and to standardize the presentation of carcasses prior to weighing. Specifications will differ in detail for different authorities. Veterinary inspection of carcasses and offal can only be carried out by qualified personnel. Where signs of disease or damage are found, the entire carcass and offal may be condemned and must not enter the food chain, but more often the veterinarian will require that certain parts, for instance those

TABLE 9.2 **Evisceration**

Main steps	Stages	Pay attention to:
Open the thorax	Saw the brisket down the middle while the carcass is on the cradle.	GHP No sharp top end of the saw.
Open the abdomen	Raise the carcass to the half-hoist. Cut the abdominal wall along the middle line.	GHP Use a knife with a rounded, blunt tip.
Free the viscera	Raise the carcass clear from the cradle/floor so that viscera fall out. Make double ties at the oesophagus- stomach and stomach- duodenum boundaries. (Note: oesophagus and rectum openings have been sealed during skinning.) Free the viscera from the carcass.	GHP Leave the thoracic and abdominal viscera intact.
Separate the viscera	Catch the edible (e.g. liver, heart, lungs) and inedible viscera in separate trays. (Note: the kidneys are removed later, after carcass splitting.)	GHP Wash the trays between animals.

where abscesses are present, be removed and destroyed (see Section 8). Factory personnel must not remove any diseased parts until they have been seen by the inspector; otherwise they may mask a general condition that should result in the whole carcass being condemned. Any instructions from the inspector to remove and destroy certain parts must be obeyed.

Trimming on a vertical hoist will minimize contamination by floor or cradle contact. Do not let anything drop on the floor, but only into skips. Personal hygiene must be scrupulous. Any spills of gut contents on to the meat should be cut off, but careful work will avoid this. The trimmed carcass should be hung on rails. If beef is quartered to facilitate handling, the cut surface is at risk.

Red meat offal should be hung on hooks. Any offal processing must be in rooms that are separate from meat-handling facilities. Intestines for human consumption must be thoroughly cleaned and washed.

Carcass washing

The primary object of carcass washing is to remove visible soiling and bloodstains and to improve appearance after chilling. Washing is no substitute for GHPs during slaughter and dressing because it is likely to spread bacteria rather than reduce total numbers. Stains of viscera and the contents of other internal organs must be cut off. Wiping cloths must not be used.

Carcass spraying will remove visible dirt and bloodstains. The water used must be clean. Soiled carcasses should be sprayed immediately after dressing before the soiling material dries, thus minimizing the time for bacterial growth. Under factory conditions some bacteria will double in number every 20–30 minutes.

In addition to removing stains from the skinned surface, particular attention should be paid to the internal surface, the sticking wound and the pelvic region. A wet surface favours bacterial growth so only the minimum amount of water should be used and chilling should start as soon as possible. Some time should be allowed for the carcasses to drip dry before they are weighed and then immediately chilled in order to minimize excess moisture in the cooler. If the cooler is well designed and operating efficiently, the carcass surface will quickly dry out, inhibiting bacterial growth.

Bubbling of the subcutaneous fat is caused by spraying with water at excessively high pressure, which may be due to the pressure in the system or a result of holding the spray nozzle too close to the carcass.

Table 9.3 summarizes the steps in evisceration, along with the major points of hygiene to focus on.

TEMPERATURE-CONTROLLED STORAGE OF CARCASSES AND MEAT

Refrigeration of carcasses

Carcasses should go into the cooler as soon as possible and should be as dry as possible. The object of refrigeration is to retard bacterial growth and extend the shelf-life. Chilling meat post-mortem from 40 C down to 0 C and keeping it cold will give a shelf-life of up to three weeks, provided high standards of hygiene were observed during slaughter and dressing.

Carcasses must be placed in the cooler immediately after weighing. They must hang on rails and never touch the floor. After several hours the outside of a carcass will feel cool to the touch, but the important temperature is that deep inside the carcass. This must be measured with a probe thermometer (not glass), and used as a guide to the efficiency of the cooling.

The rate of cooling at the deepest point will vary according to many factors, including the efficiency of the cooler, the load, carcass size and fatness. As a general guide, a deep muscle temperature of 6–7 C should be achieved in 28–36 hours for beef, 12–16 hours for pigs and 24–30 hours for sheep carcasses. Failure to bring down the internal temperature quickly will result in rapid multiplication of bacteria deep in the meat resulting in off-odours and bone-taint.

High air speeds are needed for rapid cooling but these will lead to increased weight losses due to evaporation unless the relative humidity (RH) is also high. However, if the air is near to saturation point (100 percent RH) then condensation will occur on the carcass surface, favouring mould and bacteria growth. A compromise between the two problems seems to be an RH of about 90 percent with an air speed of about 0.5 m/second. Condensation will also occur if warm carcasses are put in a cooler partially filled with cold carcasses.

The cooler should not be overloaded beyond

BOX 9.3 **GHP for carcass splitting/washing methods**

The following GHP principles should be applied in all carcass splitting/washing methods and stages:

- Sterilize the splitting equipment between carcasses.
- Use only potable water for carcass washing.
- Wash the carcasses as little as possible to prevent/reduce the spread of contamination from individual spots on to larger areas of the same carcass.
- Prevent/reduce airborne cross-contamination between carcasses by not creating aerosols during washing.
- Remove any surface contamination by trimming rather than by washing.
- Wiping cloths must not be used.

TABLE 9.3 **Carcass splitting and washing**

Main steps	Stages	Pay attention to:
Split the carcass	Work facing the back of the carcass. Split the carcass down the backbone with saw or cleaver.	GHP Saws are preferred to cleavers.
Wash the carcass	Use water spraying without excessive pressure. Wash the carcasses inside a washing cabinet.	GHP Do not wash carcasses by hosing.

the maximum load specified by the manufacturer and spaces should be left between carcasses for the cold air to circulate. Otherwise, cooling will be inefficient and the carcass surface will remain wet, favouring rapid bacterial growth.

Once filled, a cooler should be closed and not be frequently opened to avoid sudden rises in temperature. When emptied, the cooler should be thoroughly washed before refilling. Personnel handling carcasses during loading and unloading operations should follow the strictest rules regarding their personal hygiene and clothing and should handle carcasses as little as possible.

Marketing of meat under refrigeration

Chilled meat must be kept cold until it is sold or cooked. If the cold chain is broken, condensation forms and microbes grow rapidly. The same rules about not overloading, leaving space for air circulation, opening doors as little as possible and observing the highest hygiene standards when handling the meat apply. An ideal storage temperature for fresh meat is just above its freezing point, which is about -1 C (-3 C for bacon because of the presence of salt). The expected storage life given by the International Institute of Refrigeration of various types of meat held at these temperatures is shown in Table 9.4.

Under commercial conditions, meat temperatures are rarely kept at -1 C to 0 C, so actual storage times are less than expected (Table 9.5). The times would also be reduced if RH was greater than 90 percent.

Meat should be placed in the refrigerator immediately following receipt. Any parts that show signs of mould growth or bacterial slime should be trimmed off and destroyed. Hands must be thoroughly washed after handling such trimmings and knives must be sterilized in boiling water. The refrigerator should be thoroughly cleaned after finding such meat and should also be cleaned on a regular basis.

Carcasses, quarters and large primals should

BOX 9.4 **GHP for refrigeration**

The following GHP principles should be applied in all carcass refrigeration methods and stages:

- Move the carcasses into the cooler as soon as possible to speed up surface drying and hinder bacterial growth.
- Keep the carcasses on rails and without touching floors/walls and other carcasses to prevent cross-contamination.
- Do not overload the cooler.
- Adjust the cooling regime optimally in terms of air temperature, speed and relative humidity, to achieve rapid refrigeration to a deep muscle temperature of 6-7 °C with no condensation or excessive weight losses.
- Do not open the cooler doors either unnecessarily or frequently to avoid temperature fluctuations.

BOX 9.5 **Factors to consider in connection with chilling/freezing facilities**

Air must circulate efficiently around the heat source.

- Cold air must be distributed evenly through the room following a circular pattern.
- The fan should not blow air directly onto the carcasses, as the deflection from the carcasses will affect cooling of other parts of the room.
- The more the air is forced to move around the products instead of through open spaces, the better; it is preferable to have the air blown at right angles to the rails instead of along their lengths.
- Carcasses should be evenly spaced out and the room should not be overloaded. The recommended rail spaces for the different species are 660-750 cm per beef carcass, or two pork carcasses, or two calf carcasses, or six sheep carcasses, with a minimum of 5 cm between carcasses.
- It is not advisable to hang different kinds of carcasses or carcasses of very different sizes in the same room because their rates of cooling will differ.

Ice on the evaporation unit insulates the refrigeration mechanism.

- Ice should be thawed and removed from the evaporation coil at regular intervals.
- Excessive ice formation, which necessitates more frequent defrosting, can be avoided by:
  - not overloading the chiller;
  - closing the door;
  - repairing damaged insulation;
  - mopping up all water during the cleaning process.

Source: adapted from National Department of Agriculture (South Africa), 2000.

TABLE 9.4 **Expected storage life of different types of meat under refrigeration temperatures**

Type of meat	Expected storage life at -1 °C
Beef	up to 3 weeks (4-5 with strict hygiene)
Veal	1-3 weeks
Lamb	10-15 days
Pork	1-2 weeks
Edible offal	7 days
Rabbit	5 days
Bacon	4 weeks (at -3 °C)

Source: International Institute of Refrigeration, 2000.

TABLE 9.5 **Number of days needed for unpleasant smell and slime to appear on the surface of meat at various storage temperatures**

Storage temperature (°C)	Time from cutting (days)
0	20
5	10
10	5
15	5
20	3
25	2-3

Source: National Department of Agriculture (South Africa), 2000.

not be cut into smaller portions before it is necessary, as this will expose a greater surface area for bacteria to grow. Freshly cut surfaces are moist and provide a better medium for bacterial growth than the desiccated outer surfaces of cuts that have been stored for some time.

An accurate thermometer should be placed in the refrigerator and checked regularly. The temperature should remain within a narrow range (0 to +1 C).

Freezing

The aim of freezing is to extend shelf-life from weeks to several months. Bacterial growth stops at temperatures below -12 C. Above that temperature, the shelf-life of meat is limited by the actions of its own enzymes, which cause fat to become rancid. The maximum shelf-life at -18 C is:

- five months for pork;
- eight months for sheep meat;
- ten months for beef.

Summary

- The main objectives of hygienic dressing and carcass handling are to:
  - prevent contamination of the edible portions of the carcass with material from the hide/skin and from the contents of the internal organs;
  - inhibit microbial growth on the surfaces of carcasses or meat;
  - eliminate any carcasses or portions of a carcass that are deemed unsuitable for human consumption.
- Basic equipment for dressing should include provisions for cleaning and sterilizing all tools (e.g. knives, saws, cleavers), equipment and working surfaces.
- Workers should be provided with clean protective clothing and basins for washing their hands during and between operations.
- Skinning procedures should be such that direct and indirect hide to carcass contamination is prevented.
- Evisceration should prevent leakage of organ contents on to the carcass, carcass to carcass contamination and dressing surface to carcass contamination.
- Trimming should be done to remove damaged and soiled parts and standardize the appearance of the carcasses. Diseased parts should not be trimmed off until they have been seen by an inspector.
- Washing of carcasses should be done to remove visible soiling and not as a substitute for hygienic dressing. Carcasses should be washed as little as possible to prevent/reduce spread of contamination from individual spots to larger areas of the same carcass.
- Carcasses should be chilled as soon as possible after washing to speed up surface drying and hinder bacterial growth.
- The cooler conditions should be such that a deep carcass temperature of 6–7 C is achieved in 28–36 hours for beef, 12–16 hours for pigs and 24–30 hours for sheep carcasses.

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SECTION 10

Establishments: design, facilities and equipment

- Establishments should be located, designed and constructed so that contamination of meat is minimized to the greatest extent practicable.
- Facilities and equipment should be designed, constructed and maintained so that contamination of meat is minimized to the greatest extent practicable.
- Establishments, facilities and equipment should be designed to allow personnel to carry out their activities in a hygienic manner.
- Facilities and equipment that are in direct contact with edible parts of animals and meat should be designed and constructed so that they can be effectively cleaned and monitored for their hygiene status.
- Suitable equipment should be available for control of temperature, humidity and other factors as appropriate to the particular processing system for meat.
- Water should be potable except where water of a different standard can be used without leading to contamination of meat.

Design and construction of lairages

Lairages should be designed and constructed so that:

- animals can be held without overcrowding or injury, and are not exposed to climatic stress;
- there are appropriate layout and facilities for cleaning and/or drying of animals;
- ante-mortem examination is facilitated;
- floors are paved or slatted and allow good drainage;
- there is an adequate supply and reticulation of clean water for drinking and cleaning, and facilities are provided for feeding where necessary;
- there is a physical separation between lairages and areas of an abattoir where edible material may be present;
- "suspect" animals can be segregated and examined in separate areas. These areas should include facilities that are capable of secure holding of "suspect" animals pending slaughter under supervision, and should have separate and contained drainage; and
- there is an adjacent area with adequate facilities for cleaning and sanitation of transport vehicles and crates, unless there are facilities within close distance that are approved by the competent authority.

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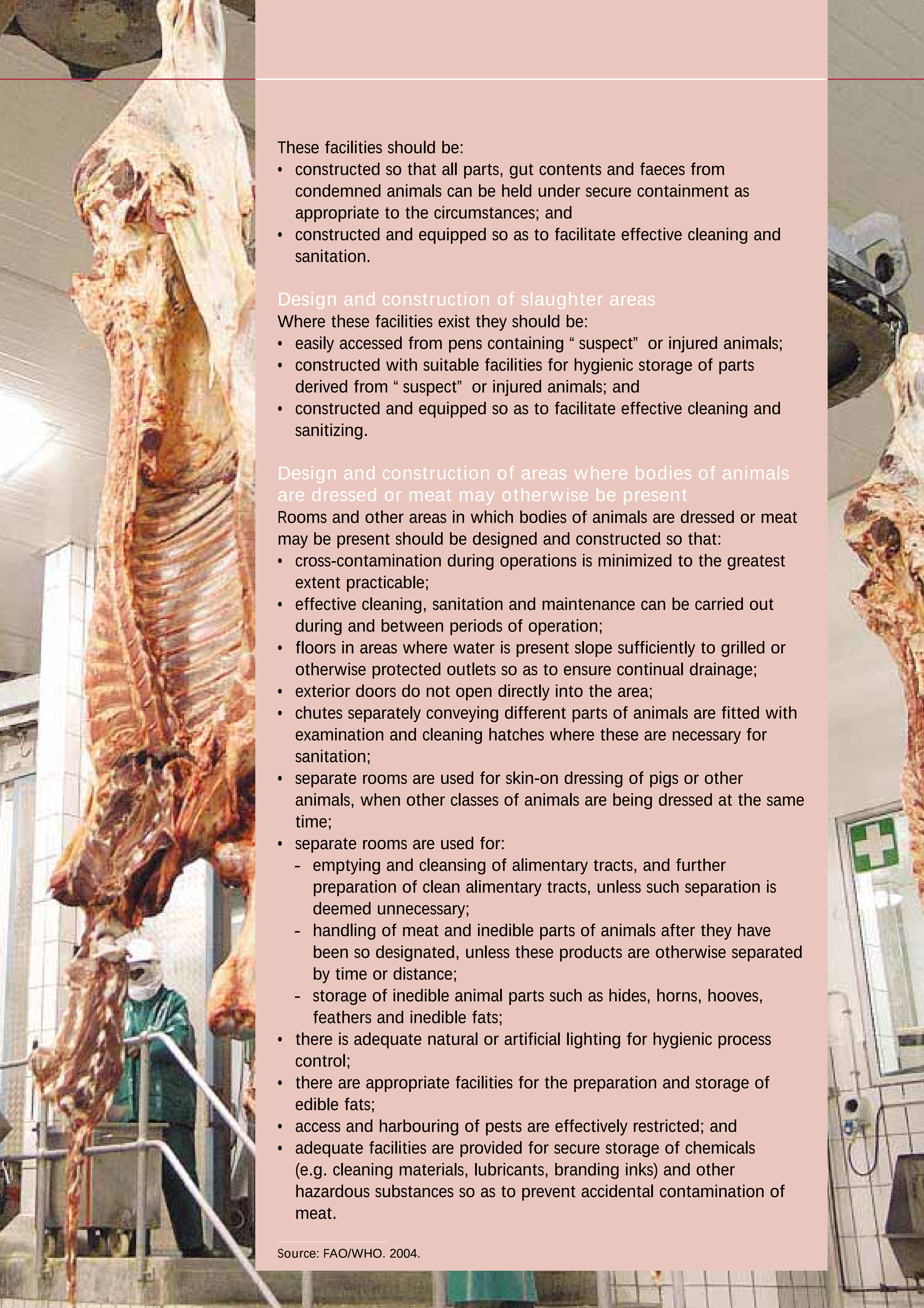

These facilities should be:

- constructed so that all parts, gut contents and faeces from condemned animals can be held under secure containment as appropriate to the circumstances; and
- constructed and equipped so as to facilitate effective cleaning and sanitation.

Design and construction of slaughter areas

Where these facilities exist they should be:

- easily accessed from pens containing " suspect" or injured animals;
- constructed with suitable facilities for hygienic storage of parts derived from " suspect" or injured animals; and
- constructed and equipped so as to facilitate effective cleaning and sanitizing.

Design and construction of areas where bodies of animals are dressed or meat may otherwise be present

Rooms and other areas in which bodies of animals are dressed or meat may be present should be designed and constructed so that:

- cross-contamination during operations is minimized to the greatest extent practicable;
- effective cleaning, sanitation and maintenance can be carried out during and between periods of operation;
- floors in areas where water is present slope sufficiently to grilled or otherwise protected outlets so as to ensure continual drainage;
- exterior doors do not open directly into the area;
- chutes separately conveying different parts of animals are fitted with examination and cleaning hatches where these are necessary for sanitation;
- separate rooms are used for skin-on dressing of pigs or other animals, when other classes of animals are being dressed at the same time;
- separate rooms are used for:
  - emptying and cleansing of alimentary tracts, and further preparation of clean alimentary tracts, unless such separation is deemed unnecessary;
  - handling of meat and inedible parts of animals after they have been so designated, unless these products are otherwise separated by time or distance;
  - storage of inedible animal parts such as hides, horns, hooves, feathers and inedible fats;
- there is adequate natural or artificial lighting for hygienic process control;
- there are appropriate facilities for the preparation and storage of edible fats;
- access and harbouring of pests are effectively restricted; and
- adequate facilities are provided for secure storage of chemicals (e.g. cleaning materials, lubricants, branding inks) and other hazardous substances so as to prevent accidental contamination of meat.

Source: FAO/WHO. 2004.

INTRODUCTION

This section is concerned with the nature of the physical environment in which the slaughter and processing of meat animals take place and its contribution to the risk of contamination of meat. Recommendations cover all stages of the process, from intake of live animals, through slaughter, to meat cutting and packing. Most establishments for slaughtering/processing meat animals will be permanent, and careful planning is necessary to ensure that the design and fabric of the buildings, facilities and equipment are conducive to minimizing contamination risk. This planning includes the choice of location (in an area free from airborne contaminants, prevalence of pests and likelihood of flooding), the layout and materials used and the equipment installed. It also concerns the provision of suitable services, e.g. water supply, service roads and the physical means of transporting meat hygienically.

An abattoir is a food factory and the essential elements in general food hygiene apply. In the context of this section, this relates to product flow, materials used in construction, facilities for separation and storage of edible and inedible products, and cleaning. The slaughter animal is a reservoir of micro-organisms present on the coat and in the gut, whereas meat from a healthy animal is generally considered to be intrinsically sterile. This gives rise to the concept of dirty and clean areas of the plant and the objective is to separate them as best possible. However, there will always be a grey area where edible meat is exposed in the presence of dirty components, and here minimal risk is achieved through best practice; these risks cannot be designed out.

In many developing countries lack of appropriate slaughtering facilities and unsatisfactory slaughtering techniques may cause unnecessary losses in meat as well as in valuable by-products, and may be a major constraint to improving animal production. Animals are slaughtered in places that are frequently polluted with blood, intestinal contents and dirty effluents, and which are not protected against insects, rodents and dogs. Meat produced under such conditions will quickly deteriorate because of the bacterial load and could cause food poisoning. In the absence of inspection, meat from sick or parasite-infested animals may well be a vector for spreading diseases affecting human beings as well as animals. Furthermore, meat quality is adversely affected by careless handling under unsanitary conditions in the meat market or shops. In addition, by-products are not properly utilized and, instead of being an asset, are considered a nuisance.

The establishment of slaughter facilities of a sufficiently high standard – but which are still simple and inexpensive – would improve the situation. When establishing slaughterhouses, each country or even each locality must adopt a solution based essentially on specific local conditions.

FAO (1988) has provided designs for small-scale modular slaughterhouses. Each module is small in size and deals with a specific activity. There are also a number of options available within the different modules (such as construction materials and methods of treatment of by-products). Each module has its own bill of quantities and can be costed separately.

The central module is the slaughter floor, which is technically equipped for killing cattle, sheep, goats and pigs. Other modules can be added to this slaughter floor for operations such as by-product utilization, meat preservation, processing and butchering.

Projects addressing all links in the production chain are more successful than those that focus on a single activity. Designs therefore include a meat market, in order to facilitate the integration of production, processing and marketing.

This section includes operational procedures for the facilities, but these may have to be modified to accommodate local conditions and customs. A case in point is the level of slaughter numbers. Depending on the number of staff and the hours worked, the throughput of animals per day can be varied from that given.

Slaughterhouses are a key element in the meat production and distribution chain, but it is essential to provide adequately trained staff to improve slaughter hygiene and meat quality, reduce raw material losses, increase utilization of by-products, and thereby increase profitability and financial returns to livestock producers.

Provision can be made in the basic design for slaughter of all species, namely, cattle (or buffalo), sheep, goats and pigs; however, because of space limitations, concurrent slaughter of different species is not possible. The abattoir capacity will depend on the mix of animals being slaughtered. Daily throughputs of approximately five large stock (e.g. cattle) or 50 small stock (sheep, goats or pigs) or a combination thereof, represent a practical maximum for small-scale modular slaughterhouses.

GENERAL PRINCIPLES

- There should be provision of an area for the containment of animals prior to slaughter (a designated lairage).
- There must be physical separation of areas for holding items designated as dirty (live animals, inedible by-products) and as clean (edible meat).
- Workrooms, structures and equipment should be designed and constructed to allow effective cleaning and monitoring of hygiene status.
- Facilities for personnel should include changing rooms, toilets with hand-washing and drying facilities, showers and a separate room for eating and drinking.
- Suitable conditions must be provided for the preparation and storage of meat.
- A maintenance programme must be followed to ensure that facilities and equipment are up to standard.

PHOTO 10.1
***Good practice:* stainless steel apron wash with knife sterilizer**

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Lairages

The lairage provides temporary housing for animals prior to slaughter and its design should take account of the following three needs: animal welfare; maintaining cleanliness; and separation of sick or suspect animals. It must be designed and constructed to allow the following physical activities:

• Animal activities	• Human activities
Eating	Ante-mortem inspection
Drinking	Droving and sorting
Lying and resting	Cleaning
Comfort movement	

Key elements in lairage design are:

- sufficient light for satisfactory ante-mortem inspection;
- floors that drain easily and do not compromise the cleanliness of animals' coats;
- no sharp objects, corners of walls, etc. that could injure animals;
- isolation pen available for containment of sick or suspect animals, with separate drainage;
- physical separation of lairage (dirty area) from the area where edible products are produced (clean area).

The welfare of animals in the lairage has important consequences for carcass hygiene because stressed animals shed more bacteria, including pathogens.

STUNNING AND BLEEDING AREA

- There must be provision to constrain an animal sufficiently to allow best practice stunning (Section 7). The design must allow rapid shackling and bleeding of the stunned animal in order to meet welfare criteria.
- The bleeding area should have a contained drainage area for blood or blood should be collected in a receptacle; floors should be kept as clean as possible.

PHOTO 10.2
***Good practice:* cattle stunning pen with raised grid to keep stunned animals off the floor and reduce coat contamination**

- This area should be physically separated from the dressing area to minimize the risk of cross-contamination of exposed meat.

Dressing area

The dressing area is used for the skinning, evisceration and final carcass-preparation stages for cattle and sheep, and for the scalding, dehairing, evisceration and polishing stages for pigs. This is an area where exposed meat is produced, so contamination from the exterior must be prevented: exterior doors should not open directly to the area and there should be measures to prevent access by insect and vertebrate pests.

Key elements in the design of this area are:

- Walls and surfaces must be smooth and impermeable to facilitate cleaning.
- Floors must be inclined sufficiently to allow continual drainage to covered drains.
- The layout must prevent cross-contamination – processing routes of inedible dirty products (skins, inedible by-products) should not cross the line carrying dressed carcasses.
- The angles between walls and floor, and between adjoining walls, where dirt could accumulate, should be coved.
- Structures and equipment that directly contact edible meat must be designed to allow thorough cleaning and disinfecting.
- Separate rooms must be available for the simultaneous dressing of pigs and ruminant species.
- There must be a separate room for the emptying and cleansing of alimentary tracts if

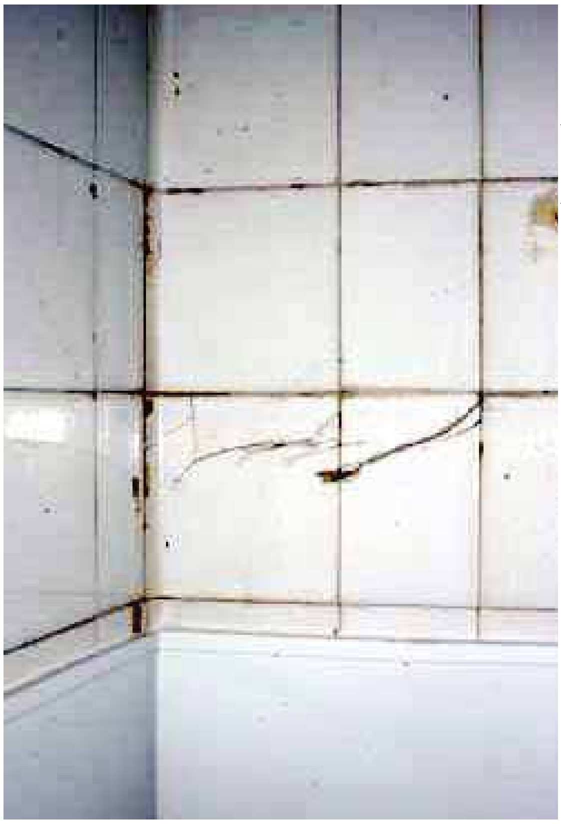

PHOTO 10.4
***Avoid:* cracked tiles: they can provide a refuge for micro-organisms**

PHOTO 10.3
A simple receptacle for catching the blood of cattle

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PHOTO 10.5
A scald tank and associated dehairer for pigs

these are prepared as an added-value product.

- Separate containers for inedible by-products must be provided and these must be stored in a separate room.

Refrigeration

The importance of good refrigeration facilities cannot be overemphasized. If meat is not preserved by any other means soon after slaughter, temperature control is vitally important in controlling the survival and growth of both spoilage and pathogenic organisms.

Adequate facilities must be provided for the chilling (or freezing) and storage of carcasses and meat. Storage should be in accordance with written specifications and the temperature of the ambient air and meat should be monitored.

Walk-in chillers should have good artificial lighting to allow safe movement of products and to facilitate identity checks and other specific activities.

Cutting rooms

The result of boning and cutting operations is exposure of numerous cut surfaces of meat that are liable to become contaminated by micro-organisms. It is imperative, therefore, that all tables and surfaces, all cutting equipment including knives, and the hands and clothing of operatives be cleaned and kept clean. To this end, adequate washing and sterilization (for knives and tools) facilities must be available.

Design features that are important in a cutting room are:

- controlled temperature to minimize the growth of micro-organisms;
- cutting surfaces in a material that can be thoroughly cleaned and that does not harbour remnants of meat tissue or fluids;
- a separate storage facility for packaging material and separation of the butchery and wrapping area from the packaging area.

Equipment

Modern equipment for the meat industry is designed to accommodate the need to be cleaned and sterilized; much is manufactured from stainless steel or other non-rusting metal alloys. Water from wash stations used for equipment and from sterilizers should duct directly to drains.

Separate and clearly identified equipment must be used for inedible and condemned parts or tissues of the animal.

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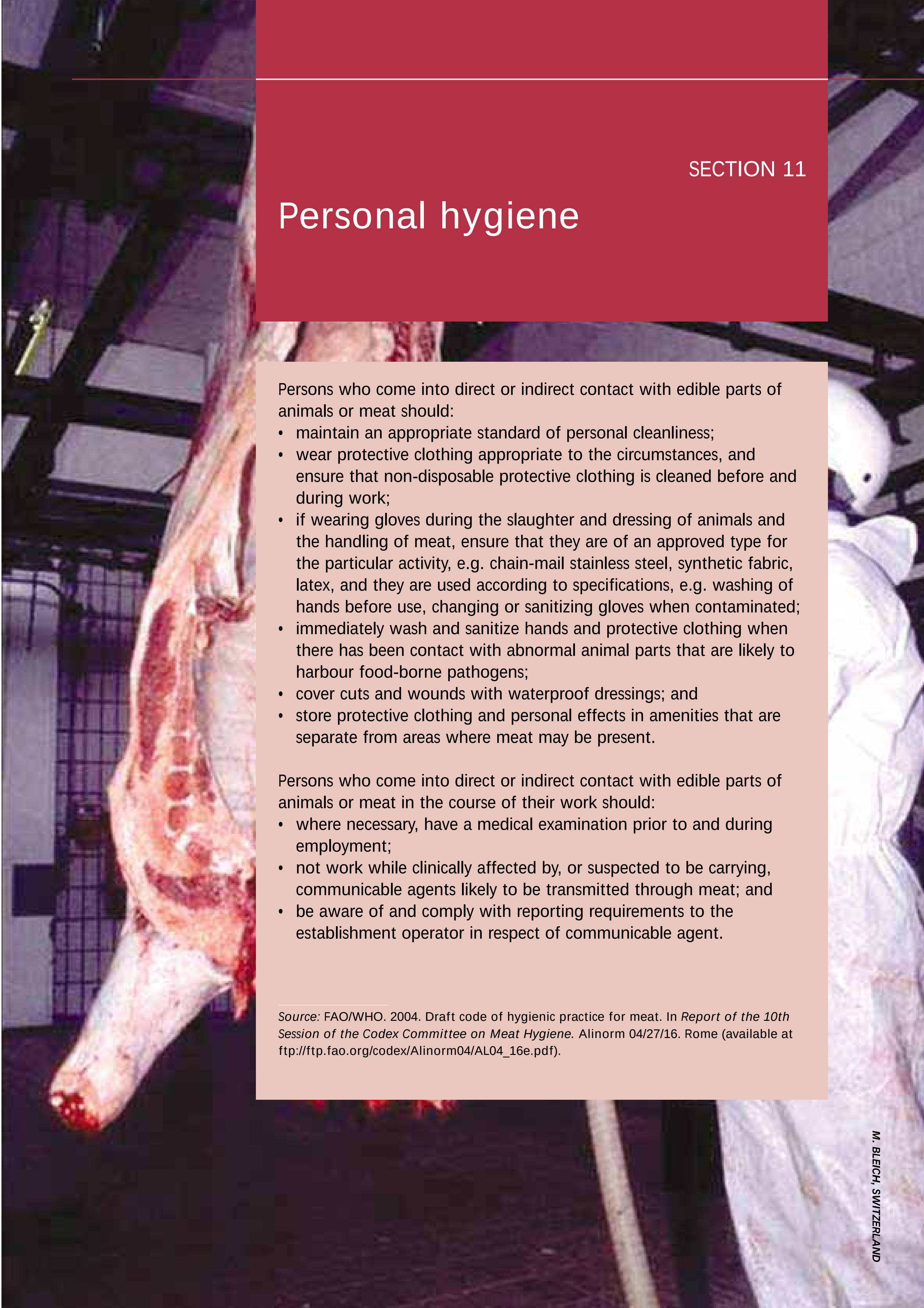

SECTION 11

Personal hygiene

Persons who come into direct or indirect contact with edible parts of animals or meat should:

- maintain an appropriate standard of personal cleanliness;
- wear protective clothing appropriate to the circumstances, and ensure that non-disposable protective clothing is cleaned before and during work;
- if wearing gloves during the slaughter and dressing of animals and the handling of meat, ensure that they are of an approved type for the particular activity, e.g. chain-mail stainless steel, synthetic fabric, latex, and they are used according to specifications, e.g. washing of hands before use, changing or sanitizing gloves when contaminated;
- immediately wash and sanitize hands and protective clothing when there has been contact with abnormal animal parts that are likely to harbour food-borne pathogens;
- cover cuts and wounds with waterproof dressings; and
- store protective clothing and personal effects in amenities that are separate from areas where meat may be present.

Persons who come into direct or indirect contact with edible parts of animals or meat in the course of their work should:

- where necessary, have a medical examination prior to and during employment;
- not work while clinically affected by, or suspected to be carrying, communicable agents likely to be transmitted through meat; and
- be aware of and comply with reporting requirements to the establishment operator in respect of communicable agent.

Source: FAO/WHO. 2004. Draft code of hygienic practice for meat. In *Report of the 10th Session of the Codex Committee on Meat Hygiene.* Alinorm 04/27/16. Rome (available at ftp://ftp.fao.org/codex/Alinorm04/AL04_16e.pdf).

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INTRODUCTION

In any food production process, contamination of the product can originate from the animal, from the environment or from the personnel involved in the operation. Human beings can suffer from diseases that may be transmitted to others via meat, or they may unwittingly carry disease agents. There are many organisms that live in and on our bodies, and cause no illness in this, their natural environment. However, if these organisms find themselves in or on foodstuffs, they may proliferate or produce toxins that can subsequently cause severe illness in the unsuspecting consumer. This section examines measures that the food handler can take to minimize the risk of contaminating the product.

PERSONAL HEALTH

The aim of any organism is to survive and proliferate, ensuring the survival of the species. This is as true of the micro-organisms that cause disease as it is of animals and human beings. When a disease-producing organism enters the body and produces disease, it multiplies, making many copies of itself to be spread in the excretions of the ill host. Thus, respiratory diseases are spread in the nasal secretions and phlegm of the patient, and disseminated to the environment and other potential victims by coughing and sneezing, whilst gastro-intestinal diseases are spread through the faeces and vomit of the patient.

If a person is unwell, and particularly if the illness is of gastro-intestinal type, that person should not handle food. It is possible that the person's hands or clothing may be contaminated with the organism responsible for the illness, even though he or she has done everything to minimize this risk. These organisms are rather hardy, and enough may survive normal washing procedures to pose a risk to the food. Some organisms also remain in the body even after the person has recovered from the episode of illness, and will be present in the faeces. It is recommended that faecal samples are screened for causes of the gastro-enteritis prior to the person returning to food handling, or there should be a period of perhaps three weeks after recovery during which time the person should not handle food.

It should be noted that some people become lifelong carriers of diseases such as typhoid.

Cuts, grazes and other skin lesions should be covered, using blue waterproof adhesive tape, or waterproof gloves. This is because, during the healing process of skin lesions, the organism *Staphylococcus aureus* proliferates around the lesion. This organism could be transferred to foods, where it produces a toxin that is responsible for food poisoning.

CLOTHING

Personal clothing can carry micro-organisms that have been gathered from a wide variety of sources into the food-processing environment. To protect the food from personal clothing, protective coveralls should be worn. The coveralls should be light in colour so that contamination can be easily identified and the coveralls cleaned. Protective clothing should be

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PHOTO 11.1
Good practice: clean light-coloured coveralls and waterproof footwear

replaced at least at the start of each working day, and whenever contaminated. Ideally, clean protective clothing should be donned at regular intervals throughout the day, at a frequency appropriate to the production volume and soiling.

Clean waterproof footwear should be worn, and should be cleaned before starting or resuming work after a break, and at the end of a period of work. This footwear should not be used in any area other than the food-processing hall, and separate footwear should be provided for staff working in high-risk areas and in dirty areas. A colour-coding system allows easy identification of equipment allocated to particular areas of the process.

The wearing of jewellery, watches and other detachable items should be discouraged. Dirt, and organisms such as *S. aureus,* can build up on and around such items, and they also pose a risk of foreign body contamination if they fall into the food.

Similarly, cosmetics, false nails or eyelashes and strong perfumes should not be allowed because of the risk of contamination and even tainting of the food.

CLEANLINESS

All parts of the body carry numerous micro-organisms, including *S. aureus*. While it is impossible for a person to remove all of these micro-organisms, careful attention to personal hygiene will minimize the risk of contamination.

Care should be taken not to touch the ears, nose, mouth, eyes and hair while working with foodstuffs. These parts of the body may carry a higher number of organisms that could be transferred to foods. Also chewing, eating, spitting and smoking should be discouraged, as these activities involve touching the mouth, and saliva may be disseminated into the environment.

Hands should be kept clean, and fingernails short. Hands should be washed:

- before entering any food-processing area;
- after using the toilet;
- after coughing, sneezing or touching the face or hair;
- after handling any waste material;
- before handling any food or food-contact equipment;
- after handling food or food-contact equipment;
- when leaving the food-processing area.

If gloves are to be worn, hands must also be clean, and the gloves must be cleaned exactly as the hands would be.

Hand-washing procedure:

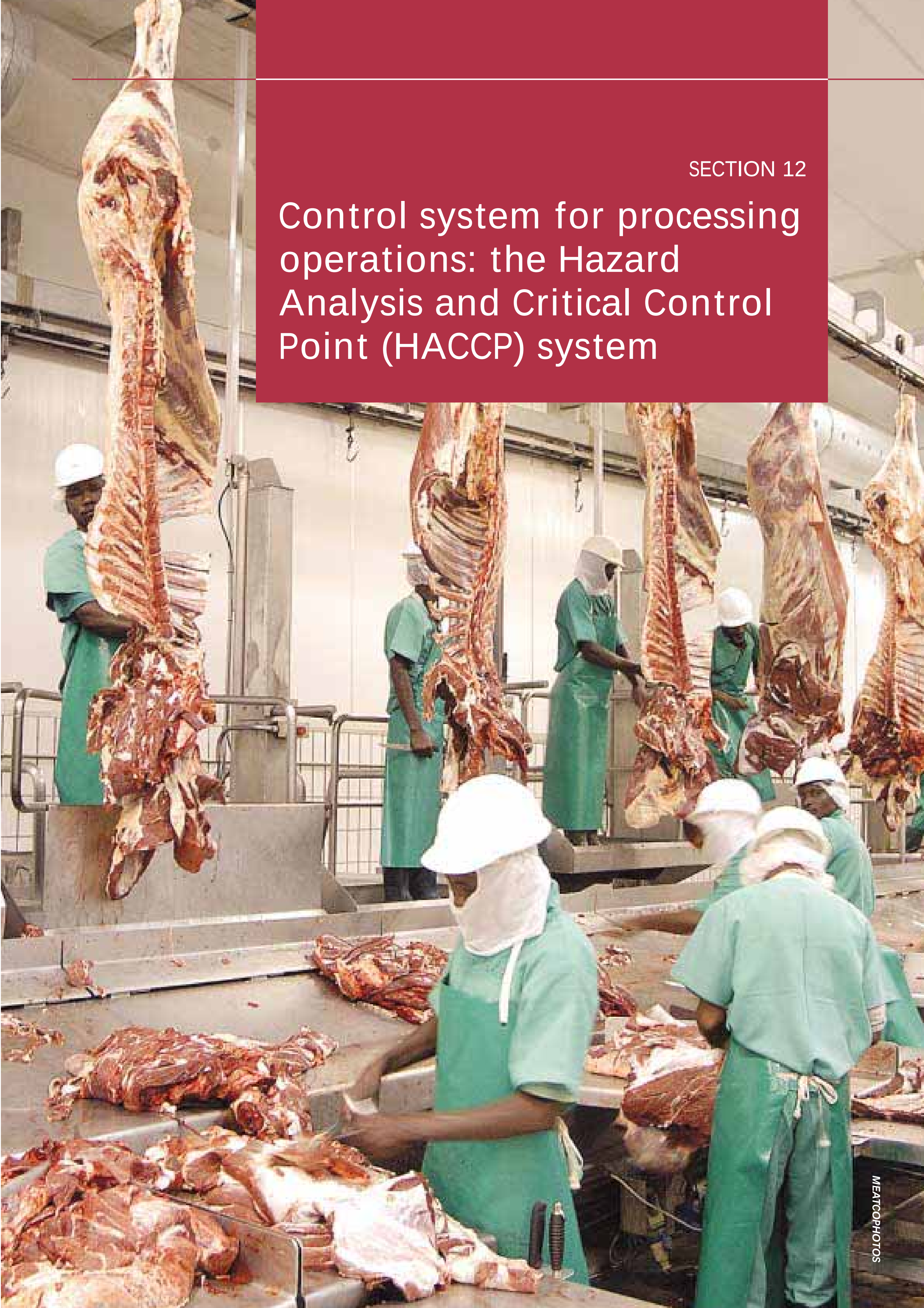
- rinse hands with warm water;
- apply soap and rub well into all parts of the hands and fingers;
- using a small brush, scrub under the fingernails, and in the creases of the hands and fingers;
- rinse the hands with warm water;
- re-apply soap and rub well in;
- rinse well;
- dry hands thoroughly.

All the above steps should be carried out to minimize the risk of contamination. An optional addition is a sanitizer, applied after the hands have been dried, but this should not replace any of the above steps.

It is important that the warm water used be clean, potable and preferably running water, and that wastewater be ducted away from the food-processing area. The use of soap is important to lift grime from the hands, and it should be unperfumed to ensure that there is no risk of tainting the foodstuffs. Drying is vital. Many micro-organisms are highly susceptible to desiccation, and the risk of contamination is reduced by drying. The method of drying should be using clean disposable towels. A re-usable towel will gradually become more contaminated than the hands it is supposed to dry, as each use will add some more micro-organisms to it. Warm-air hand-dryers may cause spread of micro-organisms in droplets into the environment, and often people do not use the dryer for a sufficient length of time to completely dry their hands.

SECTION 12

Control system for processing operations: the Hazard Analysis and Critical Control Point (HACCP) system



MEATCOPHOTOS

INTRODUCTION

The Hazard Analysis and Critical Control Point (HACCP) system is the most widely used and internationally accepted food safety management system in the world. The main goal of applying HACCP plans in abattoirs is to ensure that animals are slaughtered and dressed under conditions that mean the meat will carry minimal public health risk. A HACCP plan has the following advantages:

- it is proactive and preventive;
- it is owned by the meat plant;
- it is systematic, plant-specific and documented.

However, one should also be aware that HACCP implementation is time-consuming and creates extra work for staff. Thus a HACCP system is not easy to accommodate, particularly for small, multispecies operators. Nevertheless, HACCP is currently the meat safety management system of choice; no better alternative is presently available.

PREREQUISITE PROGRAMMES

General hygiene principles known as good hygienic practice (GHP) or good manufacturing practice (GMP) are the foundations on which a more specific HACCP system is built. Therefore, GHP is a prerequisite and there can be no effective implementation of a HACCP plan without pre-existing, effective GHP. While some lower-level risks for public health can be managed through GHP principles only, GHP alone is insufficient for managing some higher-level risks that require additional, more specifically targeted control measures provided by a HACCP system. Therefore, with respect to the frequently asked question regarding the need for a HACCP plan when GHP could be sufficient in abattoirs, the answer is: not either GHP or HACCP but rather both GHP and HACCP .

GHP incorporates several prerequisite programmes:

- **Plant maintenance**: surroundings; vehicles; hygienic plant layout (e.g. separation of clean and dirty areas); use of resistant and easy-to-clean materials (e.g. no wood); routine building maintenance; emergency maintenance procedures; equipment/ machinery maintenance and calibration; and related records.
- **Cleaning and sanitation**: storage of cleaning equipment and chemicals; procedures for cleaning/sanitation of vehicles, premises and equipment; cleaning/sanitation schedules; checks and microbiological sampling schedules; and related records.
- **Water**: supplies; sampling schedules; testing results; and related records.
- **Waste disposal**: storage and dispatch of low-risk waste materials; disposal of high-risk materials (e.g. specified risk material [SRM]); effluent disposal; and related records.
- **Pest control**: control procedures; bait plan; list of pesticides and their handling; and related records.
- **Suppliers and customers**: lists of suppliers and customers; animal/lairage records; other incoming material records and specifications; delivery records; and procedures for product recall.
- **Staff**: induction and further training of staff; routine medical certification and records; reporting of daily health problems; storage and laundering of protective clothing; and related records.

Hygienic operating procedures for the slaughter and dressing of animals (Sections 7 and 9) also represent elements of GHP.

SUMMARY OF HACCP PRINCIPLES

The seven principles of the HACCP approach are commonly explained as shown in Table 12.1

Principle 1. Hazard analysis

This is probably one of the most important and elaborate elements of the HACCP system; all other HACCP elements are either based on, or directly/indirectly generated from thorough hazard identification. It should address all individual steps, including technical aspects and any inputs (e.g. raw materials) along the production process.

Hazard definition

A hazard is any biological, chemical or physical agent present in, or condition of, food that can cause harmful effects on human health. Biological hazards are probably of greatest concern in abattoirs, and they include pathogenic micro-organisms (bacteria, fungi,

TABLE 12.1 **Principles of HACCP**

Principle	General scope
1. Hazard analysis	Identification of all likely public health hazards associated with the operation, assessment of the risk of their occurring, identification of related control measures.
2. Identification of critical control points (CCPs)	Identification of the process steps where hazards pose a high-level risk and so must be controlled.
3. Establishing critical limits at each CCP	Defining the line between acceptable and unacceptable hazard-related values, from the safety aspect, at individual CCPs.
4. Monitoring of each CCP	Establishing the system for monitoring whether hazards are effectively controlled at all the CCPs.
5. Corrective actions at each CCP	Development of actions/procedures to prevent transfer of hazards posing unacceptable risk to consumers if CCPs get out of control.
6. HACCP verification/validation	Proving that all the measures are working and that all hazards are controlled.
7. HACCP documentation	Practical, record-based proof that the checking/action activities are carried out and are effective.

viruses), microbial toxins and/or toxic metabolites, parasites and prions. Chemical hazards include residues (e.g. pesticides, polychlorinated biphenyls [PCBs], heavy metals, mycotoxins), veterinary medicines, growth promoters, cleaning/sanitation chemicals, lubricants/solvents, and pest baits. Physical hazards can include glass, plastic, metal, wood, rubber bands, string, hair, buttons, jewellery, bone splinters and insects.

Hazard identification and characterization

At each process step, every hazard and the related source/route of its transfer, as well as distribution/redistribution, on or in meat, have to be considered. Simultaneously, available control measures are determined. Using risk assessment, the risk score (e.g. a scale of 1 to 4 can be used) for a given hazard at a given production process step is allocated by considering the relationship between the probability of the occurrence and the seriousness of the consequences (Table 12.2). In the case of a low risk score (e.g. 1), no particular control measures for the hazard are required apart from those already provided by GHP. In the case of a very high risk score (e.g. 4), a CCP must be allocated to this process step (see below). If this is not possible, the step needs to be redesigned.

Control measures

Control measures can provide prevention, elimination or reduction of hazards. Most control measures are actually hygienic operating procedures normally used as part of GHP. In abattoirs, most available control measures are effective in reducing hazards, rather than in eliminating them.

Principle 2. Identification of critical control points (CCPs)

CCPs are those process steps that are vital for obtaining safe meat, and the points where the hazards must be effectively controlled (prevented, eliminated or reduced) through specified measures. Consideration as to whether a given step is a CCP or not is based on the following questions:

a) Is the hazard at this step at an unacceptable level? (If not, the step is not a CCP.)
b) Are control measures to prevent unacceptable levels available at this step? (If not, the step is not a CCP.)

TABLE 12.2 **Risk evaluation: a template example for determining risk categories**

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	Very high 4	Very high 4	High 3	High 3	Medium 2
Critical	Very high 4	High 3	High 3	Medium 2	Low 1
Moderate	High 3	Medium 2	Medium 2	Low 1	Low 1
Negligible	Medium 2	Low 1	Low 1	Low 1	Low 1

Note: on a scale of 1 to 4, low risk is 1, medium risk 2, high risk 3 and very high risk is 4.

c) If the answer to both a) and b) is yes, the step is a CCP.
d) However, when the two answers above are no and the step cannot be considered a CCP, it should be considered whether control measures are available at the previous step. If this is the case, a CCP should be assigned retrospectively to the previous step.

Although CCP allocation can differ among abattoirs depending on the specifics of the production process, including the technologies used, some generic CCPs are common to all abattoirs. For both large and small ruminant abattoirs, CCPs may include:

- acceptance of animals for slaughter,
- skinning,
- evisceration,
- chilling,
- dispatch.

For pig abattoirs, CCPs may include:

- scald and/or singe,
- evisceration,
- chilling,
- dispatch.

Principle 3. Establishing critical limits at each CCP

Critical limits are applicable only at CCPs. They represent a measurable and/or observable indicator of whether previously identified hazards have reached unacceptable levels of risk. Critical limits can differ in their nature and how they are measured. For example, chilling temperature (e.g. 4 C) is a critical limit because it prevents the growth of some pathogenic bacteria; exceeding that temperature would pose a high risk from multiplication of the pathogens. The temperature can be measured by thermometer. Another example of a critical limit is the absence of meat contamination by digesta during evisceration because it can contain enteric pathogens; the contaminated meat would pose too high a risk. Such meat contamination can be detected by either visual or instrument-aided observation, or both.

Principle 4. Monitoring of each CCP

For each CCP, regular monitoring procedures have to be established, to ensure that the CCP is controlled effectively and to detect proactively any danger from exceeding critical limits. The monitoring should include established parameters such as the methods used (e.g. sampling plans and temperature recording checks are meaningful), the frequency, the allocation of related responsibilities and recording. Although regular, monitoring is not always a continuous activity. Ideally, CCP monitoring should provide an early warning of the danger of losing control, before critical limits are exceeded.

Principle 5. Corrective actions at each CCP

Immediately when there is an indication that for any CCP the critical limit has been exceeded and the process is getting out of control, a specific, pre-planned corrective action must be taken.

Immediate effects

The immediate aim of corrective actions is a rapid regaining of control. Examples include retaining a contaminated carcass on the slaughter line and/or altering its disposition, or moving carcasses to another chiller if the temperature is moving out of control.

Longer-term effects

However, corrective actions should also include elements that aim to prevent reoccurrence, together with determining what went wrong and considering any need for retraining staff, amending instructions and procedures, maintenance works, or replacement of equipment.

Organization

Crucial preconditions for corrective actions to be effective include specifying who is responsible for carrying out a given action, and maintaining accurate/updated records.

Principle 6. HACCP verification/validation

To be effective, the HACCP plan needs to be followed in terms of both the operations and the operators, resulting in identified hazards being effectively controlled.

HACCP verification

Verification procedures need to be defined, in order to prove that what was planned and what is actually happening do not differ. Various checks can be used for HACCP verification; either the HACCP team or external auditors, or both, can carry them out. Verification checks do not need to be carried out for the whole HACCP system simultaneously; different parts of the plan can be checked at different times. Nevertheless, all the parts have to be checked within a specified time frame. Examples of verification checks include microbiological sampling of the carcasses and the environmental surfaces, auditing by customers or regulatory authorities, and on-site review of the process flow diagrams.

HACCP validation

Validation procedures need to be defined, in order to prove that the HACCP plan is effective in controlling the identified hazards. The effectiveness of HACCP-based control of hazards should be at least equivalent to, but preferably exceed, those of controls based only on GHP. Validation checks include assessment of completeness, appropriateness, adequacy and justification of all aspects of the HACCP plan. Generally, it is good practice if validation includes comparison with in-house and national performance. A HACCP plan should be revalidated if any changes are made to the plan or the production process.

Principle 7. HACCP documentation

Documentation should provide general information, details of the HACCP plan itself, and records. All documentation should be updated, complete and informative, but be as simple as possible and accessible.

General information

This includes a description of prerequisites, operating instructions, training records and similar information.

Plan information

This includes all necessary information on the HACCP team and responsibilities, product and production processes, and review procedures.

Records

These include data on monitoring, corrective actions and verification.

PREPARATIONS TO DEVELOP A HACCP PLAN

Assembling the HACCP team

A person trained in the HACCP approach should take the lead. The team should incorporate members who can provide key knowledge and skills and/or who hold responsibilities of particular interest within the company. A multidisciplinary team is beneficial, but an excessively large team will not necessarily result in increased effectiveness. The team can always call in outside experts on particular issues as required, including specialized HACCP consultants.

Gathering necessary information

The necessary background information relates to current production processes, premises and equipment, prerequisite programmes, instructions and records related to GHP, suppliers and customers, and similar.

Defining the production process

A HACCP plan is product- and process-specific. Therefore, the scope of any future plan should specify the type of product (e.g. beef, lamb or pork) and its intended use (e.g. carcass meat or processed meat).

TABLE 12.3 **Hazard analysis: a template example at selected process steps**

Process step	Hazard identification, characterization	Risk evaluation			CCP?	Control measures
		Probability	Severity	Risk category		
1.						
2.						
Etc.						

TABLE 12.4 **Summary of CCPs: a template example**

CCPs	Critical limits	Monitoring				Corrective actions		
		Procedure	Frequency	Responsibility	Records	Procedure	Responsibility	Records
CCP 1								
CCP 2								
CCP 3								
CCP 4								
Etc.								

TABLE 12.5 **HACCP validation and verification: a template example**

Validation carried out by:	Name:	Position:	Date:	Signature:

VALIDATION CARRIED OUT *BEFORE* THE PLAN IS FIRST IMPLEMENTED

Is the scope accurate?	Is process flow chart complete?	Are all hazards addressed?	Are control measures in place?	Are CCPs justified?	Are critical limits acceptable?	Are monitoring procedures given?	Are records adequate?	Does the plan cover all hazards?	Does the plan control all hazards?
YES/NO	YES/NO	YES/NO	YES/NO	YES/NO	YES/NO	YES/NO	YES/NO	YES/NO	YES/NO

VERIFICATION CARRIED OUT *AFTER* THE PLAN IS IMPLEMENTED

People responsible for verification:			Part of the plan verified:		Part of the plan verified:		Part of the plan verified:		Whole plan verified:
			Part*	Date	Part*	Date	Part*	Date	Time frame
Person 1									
Person 2									
Person 3									
Person 4									
Etc.									

* For each part, a separate signed verification record must be prepared, including any corrective actions required, whether these have been carried out and by whom.

Drawing the process diagram

The process diagram should cover the whole process that the company is in charge of, and show every step of the process. It is essential that not a single step be omitted, as this could invalidate the whole future plan.

Checking the process diagram

Confirmation of the process diagram through careful observation of the real situation across the whole process, including cross-checking with the staff operating at individual steps, will significantly improve a future plan's effectiveness.

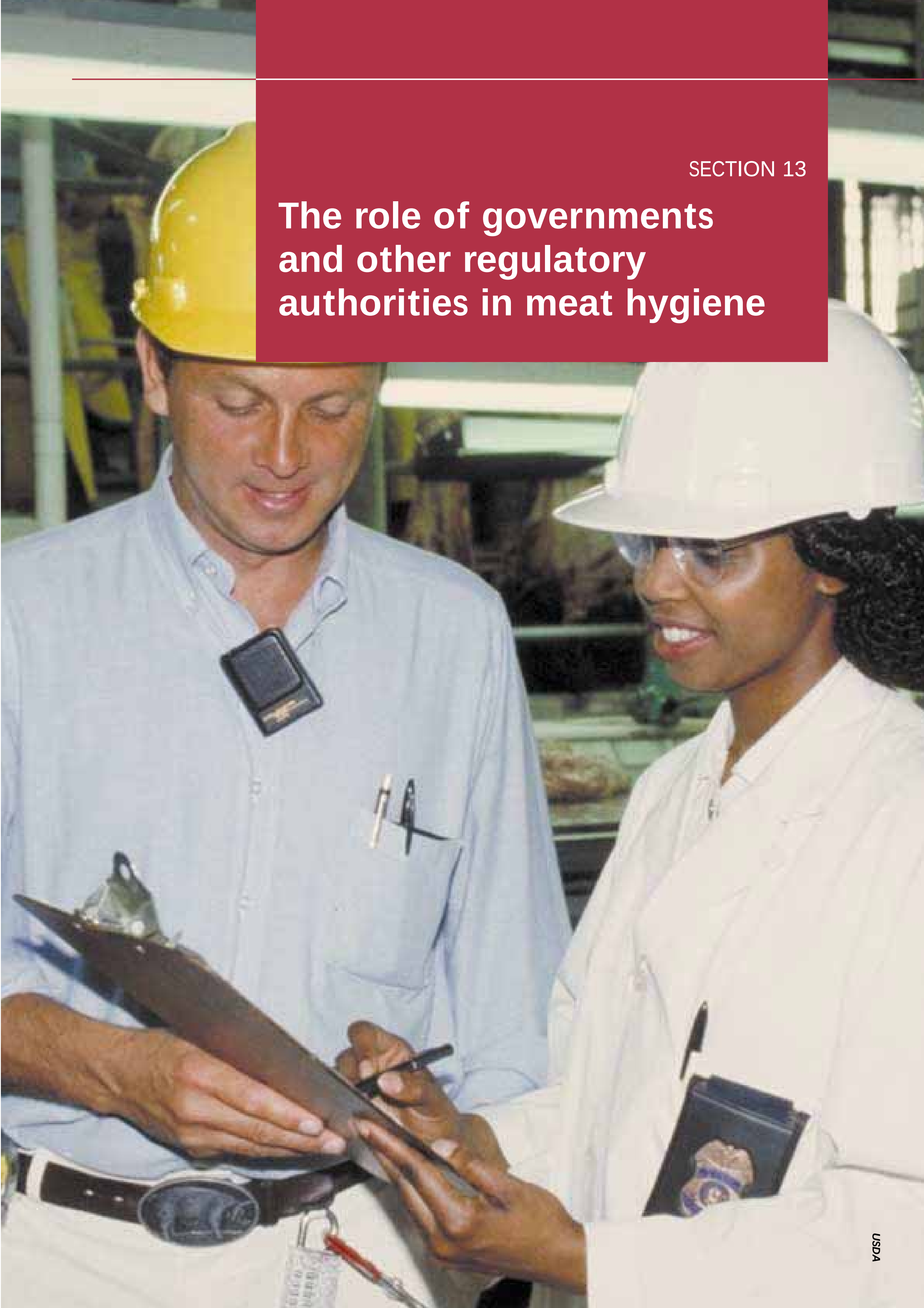
Generic examples for development/implementation of a HACCP plan

Examples of the main elements included in HACCP plan development and/or implementation are summarized in:

- Table 12.2. Risk evaluation
- Table 12.3. Hazard analysis
- Table 12.4. Summary of CCPs
- Table 12.5. Validation and verification.

SECTION 13

The role of governments and other regulatory authorities in meat hygiene



USDA

INTRODUCTION

Meat is an essential part of the global food supply and an important element of agricultural commerce and trade in many countries. Commensurate with this, food-borne disease can be a significant public health problem, and inadequate food quality and certification seriously limits the functioning of the marketplace. Meat production can also act as a vehicle for transmission of diseases of animal health importance. For these reasons, civil society demands that government play an official role in meat hygiene.

While the fundamental reasons for government involvement in meat hygiene remain unchanged, the focus of that involvement has changed markedly in the past decade. Recent legislative changes in many countries are a response to public demands for a significant reduction in food-borne risks of animal origin, and new approaches to design and delivery of meat hygiene services are emerging.

In a global regulatory environment that is increasingly intent on placing key meat hygiene responsibilities on industry, governments must still retain final responsibility for ensuring that meat hygiene goals are met. The rapidly increasing trade in meat and meat products at both local and international levels is also resulting in increased government attention to the potential for transmission of diseases of animal health importance via the food chain.

This section focuses on the changing role of government in modern meat hygiene systems. The intense current interest of governments in developing new international standards that delineate their role is a reflection of this changing focus, which will be expressed in different ways in developed and developing countries.

GOVERNMENT INVOLVEMENT IN MEAT HYGIENE

Government, which includes government veterinary services,[1] plays a key role in meat hygiene. This role will be administered by a competent authority that provides a number of essential functions. A competent authority is defined as The official authority charged by the government with the control of meat hygiene, including setting and enforcing regulatory meat hygiene requirements (FAO/WHO, 2004a).

Establishment of an institutional structure and legislative framework

Establishment of an institutional structure and legislative framework is a prerequisite for the proper functioning of a meat hygiene programme. Legislation includes acts, regulations, requirements and procedures that cover protection of human (and animal) health, protection of consumer rights and conditions of fair trading.

Institutional structure must successfully interface with non-governmental and private sectors and also facilitate a range of professional inputs, e.g. from veterinarians, human health specialists, food technologists and agricultural scientists.

Establishment of policies and standards

Within an appropriate institutional environment, one or more national competent authorities develop policies and standards for meat hygiene.[2] An array of meat hygiene regulations will describe regulatory requirements and criteria against which safety and suitability will be assessed. Safety standards will need to cover hazards of physical, biological or chemical origin.

Process and product standards should incorporate current scientific knowledge and good practice, and cover all aspects of the food chain that are within the jurisdiction of the competent authorities. This function requires the competent authority to have appropriate scientific and technical capabilities. Policies and standards must also be established for

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[1] Veterinary services refers to veterinary public and animal health activities irrespective of the organizational arrangements of competent authorities at the national level.

[2] Meat hygiene is defined as all conditions and measures necessary to ensure the safety and suitability of meat at all stages of the food chain . Safety is described in terms of appropriate application of measures to protect public health, and achievement of any quantitative outcomes for hazard control that may be required. Suitability is described in terms of meat having been produced in a hygienic manner, and meeting any non-safety quantitative standards that may be required.

competencies of inspection personnel and training requirements.

It is clear that veterinary inputs to ante- and post-mortem inspection achieve a duality of public health and animal health objectives. Irrespective of the jurisdiction of the competent authorities involved, veterinary services should integrate their activities to the maximum extent possible and practicable so as to prevent duplication of effort and unnecessary costs.

Design and implementation of ante- and post-mortem meat inspection programmes are primary meat hygiene responsibilities of national veterinary services. In the absence of a risk-based approach (see below), inspection standards are prescribed according to long-standing practice.

Policies and standards include those that are pertinent to meat hygiene throughout all parts of the food chain, e.g. for environmental contaminants, registration and use of veterinary drugs at the farm level, and chemicals that come into contact with the product during processing operations. Surveillance of products for unseen food-borne hazards, e.g. chemical contaminants, must be undertaken by the competent authority so as to identify producers that present non-complying slaughter animals and highlight emerging problems and emergency situations.

Delivery of meat hygiene services

Meat hygiene activities are usually delivered by a competent authority that must provide sufficient numbers of qualified personnel to perform allocated tasks. Resources required to support those tasks include provision of equipment, transport, laboratories and training programmes.

All inspection procedures and judgements must be exercised by personnel who have the appropriate competence. Laboratory support is essential to carrying out meat hygiene. All laboratories should be evaluated and/or accredited under officially recognized programmes to ensure that adequate quality controls and validated methodologies are in place.

Delivery of a meat hygiene service should include appropriate information loops throughout the food chain, with particular attention being paid to feedback of inspection information to producers.

Compliance and enforcement

The competent authority must ensure compliance with regulatory requirements by applying a systematic and functionally independent verification and audit programme. Legislation must provide for the ability to enforce regulatory requirements and impose sanctions in cases of non-compliance.

Public health and animal health assurances

Provision of written or equivalent assurances that meat and meat hygiene systems conform to regulatory requirements is a vital function of the competent authority. Such assurances can be provided by a competent authority which is a government agency having official jurisdiction, or by a competent body. The latter is defined as A body officially recognised and overseen by the Competent Authority to undertake specified meat hygiene activities (FAO/WHO, 2004a).

International health certificates providing official assurances for trading of meat should engender full confidence in the country of importation (FAO/WHO, 1995). Importing countries will take commensurate measures to verify certification assurances, e.g. documentary and physical checks at the port-of-entry, and third-party audit of meat hygiene systems in the exporting country.

Animal health surveillance

Animal health surveillance constitutes continuous investigation of a given population to detect the occurrence of disease for control purposes ; and monitoring constitutes on-going programmes directed at detection of changes in the prevalence of a disease in a given population (OIE, 2004). In this context, organoleptic inspection of slaughter animals can provide an important sentinel function for zoonoses, as well as for diseases solely of animal health importance. Further diagnostic tests can be applied in the case of suspect animals.

Conformance with international obligations

The World Trade Organization (WTO) Sanitary and Phytosanitary (SPS) and Technical Barriers to Trade (TBT) Agreements represent the best efforts of the global community to establish principles and guidelines governing measures for food in international trade. Signing of the

SPS Agreement in 1994 has encouraged meat hygiene measures that are based on an overall assessment of the risks to human and animal health, taking into account risk assessment techniques developed by the relevant international organizations (see below). Along with other WTO SPS obligations, inspection procedures utilized in import/export meat hygiene programmes should be comparable to those used in domestic programmes.

THE CHANGING ROLE OF GOVERNMENT IN MODERN MEAT HYGIENE SYSTEMS

In meeting meat hygiene objectives prescribed in national legislation or required by importing countries, competent authorities contribute in various ways from the direct performance of necessary [veterinary] tasks to the evaluation of [veterinary] activities conducted by operators in the agro-industrial chain (Marabelli, 2003). However, the contribution of government to modern meat hygiene programmes is undergoing rapid change. In this context, it should be noted that Veterinary Services are no longer the sole managers of animal health protection and disease control, but rather guarantors that all parties involved in food production fulfil their respective obligations to guarantee safe food for the consumer (Marabelli, 2003).

Reorganization

Competent authority

Currently there are widely varying approaches to organization of meat hygiene services within governments (OIE, 1991, 1992, 2003b). The need for clearer delineation of responsibilities between that part of government that deals with economic issues of meat production and trade, and that concerned with public health and consumer protection (WHO, 2002), has been a primary driver in reorganization of the role of government. A consolidation of multiple legislative and functional activities previously spread over several legislative jurisdictions gives practical meaning to multidisciplinary approaches to meat hygiene and implementation of a production-to-consumption approach.

Attempts to consolidate and/or better coordinate responsibilities for food regulation have now been under way in a number of countries for several years. The overarching goals are to improve the efficacy of controls and enhance public confidence in the safety of the food supply. Consolidation and simplification of legislation reduce inconsistencies in controls for different foods that cannot be attributed to differences in food-borne risks.

In some countries, the organization of food control (including meat hygiene) at the national level is now falling under a single competent authority that has responsibility for the entire food chain. Concrete benefits have already been reported, particularly in respect of clarifying roles and responsibilities, reducing overlap and duplication of programme functions, improving service delivery and facilitating federal/provincial collaboration (Evans *et al.*, 2003).

Hand in hand with these changes, the meat hygiene activities of the competent authority can be complemented by outsourcing of particular services, e.g. laboratory diagnostic services, meat inspection activities and aspects of certification (see below). In these instances, the competent authority will focus on verification and auditing functions that assure consistent delivery of services. In turn, the internal verification systems of industry should be strengthened. The competent authority must also find ways of working that facilitate a high degree of coordination between the private and public sectors. This can most effectively be done within a quality assurance framework that allows for responsible accreditation.

Competent bodies

While responsibility for meat hygiene always rests with the national competent authority, flexibility should be allowed on how the service is delivered e.g. by the Competent Authority or by an officially recognised Competent Body operating under the supervision and control of the Competent Authority (FAO/WHO, 2004a). Whatever the arrangement, the competent authority must be able to demonstrate that no conflict of interest exists between public and/or animal health objectives and economic support for the meat industry.

To be officially accredited, an inspection or certification body must be assessed against objective criteria and must comply with all regulatory activities and requirements, especially in relation to the competence, independence and impartiality of personnel (FAO/WHO, 1995). The performance of officially accredited bodies should be regularly assessed by the competent authority.

Official veterinary inspector

It is now becoming generally recognized that flexibility in the way meat hygiene services are delivered in the slaughterhouse, either by the competent authority itself or by an officially recognized competent body operating under the supervision and control of the competent authority, is a primary goal of a modern meat hygiene programme. However, the role of the official veterinary inspector in modern meat hygiene systems is still subject to international debate (FAO/WHO, 2004a). The level of involvement of the official veterinary inspector, i.e. the veterinary employee of the competent authority who carries out official meat hygiene duties in the slaughterhouse, is changing as structural changes in systems for delivery of meat hygiene services continue.

Whatever the outcome of this debate, it is the official veterinary inspector who has the final responsibility of ensuring that all meat hygiene requirements are met. The competent authority should establish the knowledge and ability requirements of all personnel involved, including the role of the official veterinary inspector. Acceptance of competency standards is becoming a key requirement in judging the equivalence of meat hygiene systems for meat in international trade.

Privatized delivery of meat hygiene

In a modern meat hygiene environment, competent bodies or competent persons may be engaged by industry to undertake prescribed meat hygiene activities, including ante- and post-mortem inspection, as approved by the competent authority (FAO/WHO, 2004a).

Use of private non-veterinary personnel to carry out ante- and post-mortem inspection activities is now well established within a number of national programmes. However, all ante- and post-mortem inspection arrangements should satisfy the principles of independence, competence of inspectors and impartiality, and must be carried out under the overall supervision and responsibility of the competent authority.

The competent authority should specify the competency requirements for all persons engaged in inspection and verify the performance of those persons (FAO/WHO, 2004a).

The Meat Safety Quality Assurance (MSQA) system implemented by industry in Australia is the most comprehensive example of privatized delivery of meat hygiene services (see below). The official veterinary inspector responsible for a specific slaughterhouse ensures that the MSQA system meets regulatory requirements on an ongoing basis. In total, six levels of verification are built into the system:

- company quality assurance teams verifying compliance with MSQA implemented by industry;
- competent authority on-plant supervisors ensuring daily compliance with MSQA;
- competent authority regional veterinary auditors verifying compliance with overarching regulatory requirements on a monthly basis;
- annual independent veterinary audit by the competent authority;
- independent compliance assessment by competent authority;
- external (overseas) audit.

Other examples of privatization of specific meat hygiene functions are increasing on a global basis. Individual health certification of groups of slaughter animals is becoming a common practice in a number of countries, e.g. for zoonotic diseases, veterinary drug residues and vaccination regimes. Veterinary ante-mortem inspection may also be provided by private contractors at the level of livestock production (McKenzie and Hathaway, 2002).

Privatization should only be considered where meat hygiene objectives (including animal health objectives) can be achieved without the burdensome addition of another layer of regulation. There must be clear economic incentives to government and the changes must be acceptable to the competent authorities in importing countries. In this context, concerns have been raised over the potential for privatization of meat hygiene services in developing countries (WHO, 2002).

In the absence of good agricultural and veterinary practice during primary production, and well developed quality assurance systems and risk-based process control (e.g. Hazard

Analysis and Critical Control Point [HACCP]), intensive involvement of government in meat hygiene arguably still presents the most effective way of assuring required outcomes. This may be the situation that exists for some years to come in developing countries.

Enhancing audit and enforcement

A number of institutional models are emerging for the audit and enforcement of regulatory requirements in meat hygiene. It is generally recognized that the effectiveness and consistency of audit and enforcement must be demonstrably improved, especially if consumers are to have ongoing confidence in the safety of the food supply.

The competent authority auditing and enforcing standards may be separate to, or included in, the centralized competent authority promulgating meat hygiene policy and standards. Notwithstanding this, audit and enforcement remains decentralized in some countries, i.e. undertaken by regional or local government. Whatever the organizational structure, a theme of greater centralization of responsibility and checking-the-checker is becoming standard audit practice. Procedures and sanctions that are risk-based are becoming more common, and private third parties are emerging as independent auditing bodies.

Uptake of risk analysis

International trends

A risk-based approach to food safety is the contemporary cornerstone of Codex Alimentarius standards for food in international trade (see below) and application of this discipline has irrevocably changed the approach of governments in meat hygiene. While developing technical capability to assess food safety risks and properly benefit from the provisions of the WTO SPS Agreement, competent authorities must also employ other components of risk analysis, i.e. risk management and risk communication, if they are effectively to protect human health and ensure fair trade.

Risk analysis in food safety has its contemporary roots in the emerging global climate of free trade that is based on removal of barriers constituting unjustified protection of domestic economic advantage. However, the global community fully recognizes the sovereign right of governments to place appropriate controls on food products crossing their borders so as to protect human health. The WTO SPS Agreement specifies international obligations in terms of the establishment and implementation of such controls.

Risk analysis is increasingly becoming cross-sectoral in nature, and it is generally recognized that all biosecurity processes should be applied with the greatest degree of consistency possible. The consolidation of risk-based approaches at the national level has already resulted in significant changes in regulatory policy, infrastructure and scientific endeavour in a number of countries

In a contemporary meat hygiene environment, competent authorities should utilize risk assessment to the greatest extent possible in the development of public health standards. National competent authorities are facing increased demands for technical expertise to develop domestic standards on this basis, while at the same time endeavouring to meet risk analysis obligations as assumed under international trading agreements.

The central role of risk analysis in modern meat hygiene systems has been described in Section 1. As primary producers and processors express concerns about the costs of compliance with new regulatory requirements and their effect on international competitiveness, competent authorities are increasingly pursuing meat hygiene measures that do not unnecessarily restrict business enterprise. Development of standards that are outcome- and risk-based assists achievement of this goal.

Uptake by governments

To date, risk analysis and risk-based standards have been formalized in national legislation to varying degrees. Risk assessments provided by international or regional organizations are increasingly complementing those generated at the national level. National sovereignty is reflected in risk management decisions that reflect agreed public health goals.

In some countries, increasing attention to formalized application of a generic framework for managing food-borne risks has resulted in a legal obligation to routinely include stakeholders other than the competent authority in the risk management decision-making process (see Section 1).

Examples of standard-setting according to risk-based approaches are predominantly found in the areas of primary production and process control. Simulation modelling of risk management interventions in these areas is available for some hazard/product combinations, but quantitative standards resulting from such work are still limited in number. Removal of resource-intensive post-mortem inspection procedures where they have been shown to be of negligible benefit has been the most visible outcome to date. In the absence of a risk-based evaluation, procedures have to remain based on current scientific knowledge and practice.

There is only limited scientific evidence linking traditional ante- and post-mortem inspection with measurable outcomes in terms of human health. Additionally, there has been limited progress in tailoring inspection procedures to the spectrum and prevalence of the diseases/defects present in a particular class of slaughtered livestock from a specific geographical region. A risk assessment approach can be used to address these problems and facilitate the proportional allocation of meat hygiene resources according to level of risk.

Greater emphasis is being placed on risk communication in most countries, and competent authorities are learning important lessons in the translation of complex meat hygiene information into readily understandable messages for the general public. Increasingly, more proactive communication methods are being employed. Provision for broad-based stakeholder consultation is seen as a critical element in an effective risk communication strategy.

The trend towards institutional approaches that bridge the animal and public health sectors/disciplines involved is increasingly apparent at the national level and the traditional focus on regulating individual production systems is shifting to one of ensuring confidence in overall regulatory frameworks at all levels. Development of a more unified approach will have particular benefit in developing countries in assisting general understanding of risk assessment and optimizing the use of scarce technical resources.

Development of integrated "production-to-consumption" meat hygiene systems

Problems exist in many countries and federations not necessarily because of lack of legal meat hygiene instruments, but because of a broad disparity in the means to respond adequately and consistently to food hygiene situations in specific sectors of the food chain, many of which spill over into other sectors. If a production-to-consumption approach to meat hygiene is to take root, an integrated, proactive and multidisciplinary response to such situations is required (European Commission, 2000). A General Food Law (including relevant aspects of animal feeding) that is readily understandable by all food operators is one means of enhancing food hygiene, including meat hygiene.

There are other reasons why meat hygiene regulation is increasingly focused on the entire food supply chain from primary production (including animal feeding and use of agricultural chemicals) through to consumption. Multiple and integrated interventions are needed to ensure meat products that are safe and suitable, and it is important that those products have not had to be produced under a burdensome regulatory regime. Risk analysis is embedded in design of a production-to-consumption approach, and industry is offered flexibility in the way it achieves specified food safety outcomes at certain points in the food chain (see Section 1).

Good hygienic practice includes the need for a systematic process to gather, evaluate and document scientific and other information as the basis for hygiene measures. Organization and dissemination of information throughout the food chain involves multidisciplinary inputs. As an example, effective implementation of risk-based ante- and post-mortem inspection procedures is dependent on ongoing monitoring and exchange of information involving a range of professionals and non-government sectors.

Contaminants that are not intentionally added to food are increasingly being recognized as hazards of concern in meat and meat products. These may arise as a result of environmental contamination, but they also may arise as a result of agricultural practices, production, processing, storage, packaging, transport or fraudulent practices. Despite widespread occurrence, safety standards for contaminants at each step of the food chain, i.e. from animal feeding through to retail sale, are often lacking or are developed under different legislative jurisdictions. It is clear that a production-to-consumption approach to control such hazards is imperative.

In the case of the dioxin crisis in Belgium in 1999, it was shown that the high level of dioxin residues in some animal products originated from contaminated feed, but one of the major difficulties encountered in bringing the problem under control was the regulatory inability to impose a single emergency measure. Another major difficulty was the lack of traceability of feed ingredients.

Development of standards based on an integrated production-to-consumption approach to meat hygiene ideally requires application of a generic framework for managing food-borne risks (see Section 1). This is likely to be difficult in developing countries if there is poor communication anong animal health, veterinary public health and medical professionals, and poor monitoring and feedback of information for zoonoses and other food-borne diseases.

Impact of international standards

Under the auspices of FAO and WHO, the Codex Alimentarius Commission (CAC) is the primary standard-setting agency for food in international trade. The Codex Alimentarius, or food code, represents the best efforts of the global community to formulate and harmonize international food standards that ensure protection of public health and promote fair practices in food trade.

Recognition of Codex Alimentarius by the WTO SPS and TBT Agreements (1994) as a benchmark against which national standards and food control systems should be evaluated considerably increased the importance of the code.[3] In recent times, the activities of the CAC have reached much wider than Codex Alimentarius and now directly influence contemporary thinking on food control throughout the global food chain.

In a general context, Codex standards provide direct benefits to the food sector in all countries by:

- providing guidance on cost-effective and efficient production of safe, suitable, high-quality food;
- establishing norms for good agricultural practice (GAP), good veterinary practice (GVP) and good hygienic practice (GHP) throughout the food chain;
- enhancing access to high-value markets by use of harmonized standards (including those for organic products);
- having legal status under the WTO SPS and TBT Agreements,[4] thereby requiring countries to justify non-adoption of Codex standards according to strictly defined criteria;
- facilitating the removal of technical barriers to trade;
- facilitating acceptance of equivalent systems and standards.

It is now essential that all countries contribute to the continuing development of the Codex Alimentarius if they are to optimize meat production in terms of meat hygiene and access to international markets. As well as protecting consumers' health, availability of food standards reduces the costs of doing business, e.g. risk of international fraud and the costs of finding reliable trading partners. Consumers are also protected from buying inferior food. In providing such benefits to both producers and consumers, Codex standards promote economic welfare and are a prerequisite to the operation of a well functioning market. If standards are harmonized between countries, they naturally facilitate trade (international and domestic) and trade itself is generally judged to promote economic development (FAO/WHO, 2002).

For many years, FAO and WHO have complemented the activities of the CAC by providing technical assistance to developing countries in the area of food control. Further to this, a recent FAO/WHO Working Group has recommended that FAO and WHO enhance the participation of developing countries from all regions in all aspects of the [Codex] scientific advice process, including prioritization of needs and outreach to scientific experts (FAO/WHO, 2004b). This includes nurturing of regional efforts to generate and collect data for risk assessments.

[3] The WTO TBT Agreement covers all aspects of food standards not covered by the SPS Agreement.

[4] TBT measures must be shown to have a legitimate purpose, be proportional to the desired purpose, and be based on international standards. Codex standards on quality, composition, labelling, nutrition and methods of analysis are all relevant.

The recent FAO/WHO report on the evaluation of Codex Alimentarius (FAO/WHO, 2002) contains far-reaching recommendations in this respect and calls for a strengthening of health risk analysis. The report also identifies that capacity building in risk analysis is essential to developing countries if they are adequately to ensure the protection of their own citizens and benefit from a globalizing market in food.

Recent work by international standard-setting bodies has given clarity to utilization of a precautionary response in the face of potential food safety problems. When available scientific information identifies a hazard in food that may present a human health risk, but the specific nature and the extent of that risk is unknown, the WTO SPS Agreement states that a competent authority may act in a precautionary manner and adopt provisional measures until more complete risk assessment information is available. Thus governments retain broad powers in law to take provisional hygiene measures when faced with new or emerging food safety threats. Such actions are sometimes seen as technical barriers to trade by exporting countries, and this illustrates the need for national risk assessment capability.

Recognition of quality systems by competent authorities

A quality assurance (QA) system is the organisational structure, procedures, processes and resources needed to implement quality assurance (FAO/WHO, 2004a). The ISO 8402 Standard states that QA is all the planned and systematic activities implemented within a quality system that provide confidence that an entity will fulfil requirements for quality. Those who benefit from inspection provided by the competent authority or competent body, e.g. farmers and meat-processing companies, are increasingly committing themselves to quality systems due to demand from their customers (Gary, 2003).

Transfer of primary responsibility for meat hygiene to industry is another important driver for the recent emergence of voluntary QA systems. Where industry has demonstrated successful implementation of such systems, the competent authority is increasingly likely to take these systems into consideration when applying its own meat hygiene controls and verification systems.

In some countries, formal QA procedures are being put in place to assure competence and reliability of meat hygiene activities delivered on an ongoing basis (Gerster *et al.*, 2003). Creating a quality system is a simple way of implementing the objectives contained in the quality policies that are written by government managers. Tools such as quality accreditation are seen as necessary components of modern economic management systems (Marabelli, 2003).

QA systems can be extended in the case of ante- and post-mortem inspection to co-regulatory systems that integrate industry and veterinary service activities (Butler, Murray and Tidswell, 2003). In Australia, these systems are based on HACCP principles, are nationally uniform and extend from production to consumption . Through a co-regulatory partnership arrangement, the competent authority is responsible for the broad design of the inspection system and its audits and sanctions, while the industry is responsible for further developing, implementing and maintaining the system.

Integrated quality control systems that link information on animal health status at the farm level with selection of slaughter pigs, processing and inspection requirements have been developed in some countries, e.g. rearing and slaughter of finishing pigs in the Netherlands. This approach involves farmers, meat processors and the competent authority responsible for meat hygiene, and the quality systems should be based on internationally accepted norms, e.g. ISO standards. The results from the slaughterhouse are continuously fed back to the farm so as to improve food safety and the profitability of animal production.

Other challenges

A number of other challenges face competent authorities administering modern meat hygiene systems. These include:

- **Facilitating new technologies.** Technological possibilities in meat production and processing are now increasing exponentially. In the past the main goal was to achieve higher productivity and profitability. Now that consumers are increasing their voice in the marketplace, new technologies are often focused on different goals, e.g. higher levels of safety, quality and environmental demands. Competent authorities have the responsibility of ensuring that such technologies achieve their stated goals, and this often involves detailed risk assessment.

- **Preventing intentional contamination such as bioterrorism**. The food chain is increasingly receiving attention from governments as a potential vehicle for bioterrorism. Strategic responses to the risks of bioterrorism are well advanced in the United States of America and the impact of new food standards to prevent such acts is being felt around the world. The long-term effectiveness of such standards is subject to international debate.
- **Increasing levels of epidemiological surveillance and preparedness for animal health.** Animal health surveillance and monitoring allow veterinary services to identify and control significant endemic or exotic diseases within their territory, and substantiate reports on the animal health situation in their country. Both functions provide essential inputs to import risk analysis.

An example of risk-based monitoring of zoonoses is well illustrated in the World Organisation for Animal Health (OIE) standard for bovine spongiform encephalopathy (BSE) (OIE, 2004). It is stated that surveillance strategies should be determined by, and commensurate with the outcome of risk assessment and have two primary goals: to determine whether BSE is present in a country and, once it has been detected, monitor development of the epizootic, direct control measures and monitor their effectiveness.

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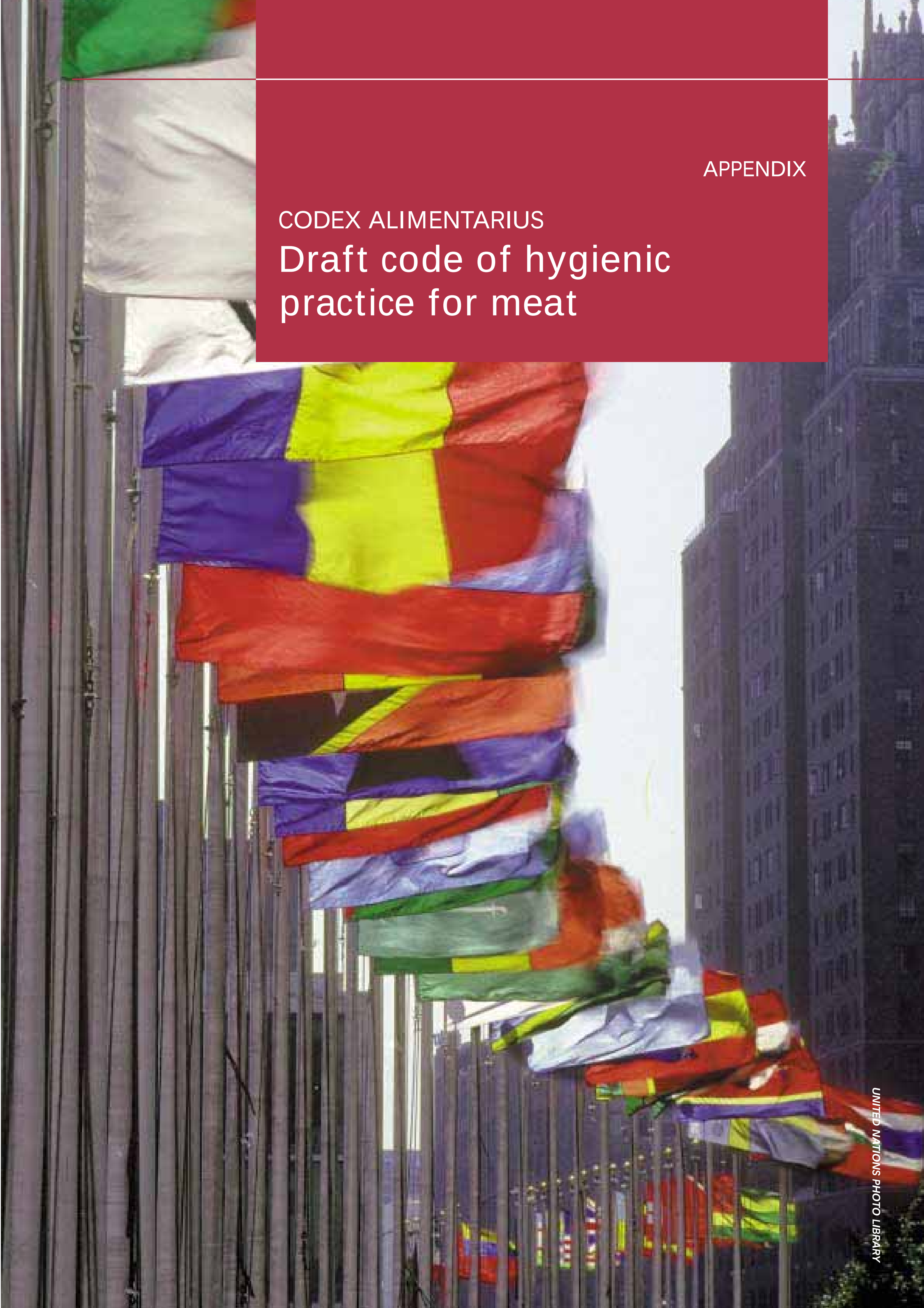
APPENDIX

CODEX ALIMENTARIUS

Draft code of hygienic practice for meat



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Contents

1. INTRODUCTION

1. Meat has traditionally been viewed as a vehicle for a significant proportion of human food-borne disease. Although the spectrum of meat-borne diseases of public health importance has changed with changing production and processing systems, continuation of the problem has been well illustrated in recent years by human surveillance studies of specific meat-borne pathogens such as *Escherichia coli* O157:H7, *Salmonella* spp., *Campylobacter* spp. and *Yersinia enterocolitica*. In addition to existing biological, chemical and physical hazards, new hazards are also appearing, e.g., the agent of bovine spongiform encephalopathy (BSE). Furthermore consumers have expectations about suitability issues which are not necessarily of human health significance.

2. A contemporary risk-based approach to meat hygiene requires that hygiene measures should be applied at those points in the food chain where they will be of greatest value in reducing food-borne risks to consumers. This should be reflected in application of specific measures based on science and risk assessment, with a greater emphasis on prevention and control of contamination during all aspects of production of meat and its further processing. Application of HACCP principles is an essential element. The measure of success of contemporary programmes is an objective demonstration of levels of hazard control in food that are correlated with required levels of consumer protection, rather than by concentrating on detailed and prescriptive measures that give an unknown outcome.

3. The activities of the Competent Authority having jurisdiction at the slaughterhouse (usually Veterinary Administrations[1]) very often serve animal health as well as public health objectives. This is particularly the case in relation to ante- and post-mortem inspection where the slaughterhouse is a key point in animal health surveillance, including zoonoses. Regardless of jurisdictional arrangements, it is important that this duality of functions is recognised and relevant public health and animal health activities are integrated.

4. A number of national governments are implementing systems that redefine the respective roles of industry and government in delivering meat hygiene activities. Irrespective of the delivery systems the competent authority is responsible for defining the role of personnel involved in meat hygiene activities where appropriate, and verifying that all regulatory requirements are met.

5. The principles of food safety risk management[2] should be incorporated wherever appropriate in the design and implementation of meat hygiene programmes. Specifically, work conducted by JEMRA, JECFA and FAO/WHO Expert Consultations and resulting risk management recommendations should be considered. Further, newly-recognised meat-borne risks to human health may require measures additional to those usually applied in meat hygiene, e.g., the potential for zoonotic transmission of central nervous system disorders of slaughtered livestock means that additional animal health surveillance programmes may need to be undertaken.

2. SCOPE AND USE OF THIS CODE

6. The scope of this code covers hygiene provisions for raw meat, meat preparations and manufactured meat from the time of live animal production up to the point of retail sale. It further develops 'The Recommended International Code of Practice: General Principles of Food Hygiene'[3] in

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[1] OIE is currently working on a standard addressing ante- and post-mortem activities in the production of meat to reduce hazards of public and animal health significance', to provide additional guidance in this area.

[2] Proposed Draft Working Principles for Risk Analysis (CX/GP 02/3); Proposed Draft Working Principles for Microbiological Risk Management (CX/FH 01/7 and ALINORM 03/13 paras. 99-128)

[3] CAC/RCP 1-1969, Rev. 4-2003

respect of these products. Where appropriate, the Annex to that code (Hazard Analysis and Critical Control Point System and Guidelines for its Application) and the Principles for the Establishment and Application of Microbiological Criteria for Foods[4] are further developed and applied in the specific context of meat hygiene.

7. For the purposes of this code, meat is that derived from domestic ungulates, domestic solipeds, domestic birds, lagomorphs, farmed game, farmed game birds (including ratites) and wild game. This Code of Practice may also be applied to other types of animals from which meat is derived, subject to any special hygienic measures required by the competent authority. Further to general hygiene measures applying to all species of animal as described above, this code also presents specific measures that apply to different species and classes of animals, e.g. wild game killed in the field.

8. The hygiene measures that are applied to the products described in this code, should take into account any further measures and food handling practices that are likely to be applied by the consumer. It should be noted that some of the products described in this code may not be subjected to a heat or other biocidal process before consumption.

9. Meat hygiene is by nature a complex activity, and this code refers to standards, texts and other recommendations developed elsewhere in the Codex system where linkages are appropriate, e.g., Principles for Food Import and Export Inspection and Certification (CAC/GL 20 - 1995), Proposed Draft Principles and Guidelines for the Conduct of Microbiological Risk Management (CX/FH 01/7 and ALINORM 03/13 paras. 99-128), General Guidelines for Use of the Term "Halal" (CAC/GL 24-1997) and recommendations of the *Ad hoc* Intergovernmental Task Force on Animal Feeding (ALINORM 01/38 and ALINORM 01/38A).

10. Where appropriate, linkages should also be made to the standards, guidelines and recommendations contained in the OIE Terrestrial Animal Health Code that relate to zoonoses.

11. Subsets of the general principles (Section 4) are provided in subsequent sections within double-line boxes'. Where guidelines are provided at the section level, those that are more prescriptive in nature are presented in single-line boxes'. This is to indicate that they are recommendations based on current knowledge and practice. They should be regarded as being flexible in nature and subject to alternative provisions so long as required outcomes in terms of the safety and suitability of meat are met.

12. Traditional practices may result in departures from some of the meat hygiene recommendations presented in this code when meat is produced for local trade.

3. DEFINITIONS

13. For the purposes of this code, the following definitions apply. (Note that more general definitions relating to food hygiene appear in The Recommended International Code of Practice: General Principles of Food Hygiene[5]).

Abattoir	Any establishment where specified animals are slaughtered and dressed for human consumption and that is approved, registered and/or listed by the competent authority for such purposes.

[4] CAC/GL 21-1997

[5] Recommended International Code of Practice: General Principles of Food Hygiene (CAC/RCP 1-1969, Rev.4-2003)

Animal	Animals of the following types: • Domestic ungulates; • Domestic solipeds; • Domestic birds, i.e. poultry; • Lagomorphs; • Farmed game; • Farmed game birds, including ratites; • Wild game, i.e. wild land mammals and birds which are hunted (including those living in enclosed territory under conditions of freedom similar to those of wild game); • Animals as otherwise specified by the competent authority.
Ante-mortem inspection[6]	Any procedure or test conducted by a competent person on live animals for the purpose of judgement of safety and suitability and disposition
Carcass	The body of an animal after dressing.
Chemical residues	Residues of veterinary drugs and pesticides as described in the Definitions for the Purpose of the Codex Alimentarius[7].
Competent authority[8]	The official authority charged by the government with the control of meat hygiene, including setting and enforcing regulatory meat hygiene requirements.
Competent body	A body officially recognised and overseen by the competent authority to undertake specified meat hygiene activities.
Competent person	A person who has the training, knowledge, skills and ability to perform an assigned task, and who is subject to requirements specified by the competent authority.
Condemned	Examined and judged by a competent person, or otherwise determined by the competent authority, as being unsafe or unsuitable for human consumption and requiring appropriate disposal.
Contaminant	Any biological or chemical agent, foreign matter, or other substance not intentionally added to food that may compromise food safety or suitability[9].
Disease or defect	Any abnormality affecting safety and/or suitability.
Dressing	The progressive separation of the body of an animal into a carcass and other edible and inedible parts.

6 These and other procedures and tests stipulated by the Competent Authority, may also be conducted, in particular for the purposes of animal health.

7 Procedural Manual of the Codex Alimentarius Commission

8 The Competent Authority provides official assurances in international trade of meat. Requirements for certification for public health and fair trade purposes have been developed by the Codex Committee on Food and Import and Export Inspection and Certification Systems (ref. CAC/GL 26-1997). Requirements for certification for animal health (including zoonoses) purposes are contained in the OIE Terrestrial Animal Health Code (ref. Section 1.2 Obligations and ethics in international trade). Both should be read in parallel where veterinary certification is required.

9 Recommended International Code of Practice: General Principles of Food Hygiene (CAC/RCP 1-1969, Rev 4-2003)

Establishment	A building or area used for performing meat hygiene activities that is approved, registered and/or listed by the competent authority for such purposes.
Establishment operator	The person in control of an establishment who is responsible for ensuring that the regulatory meat hygiene requirements are met.
Equivalence	The capability of different meat hygiene systems to meet the same food safety and/or suitability objectives.
Food safety objective (FSO)	The maximum frequency and/or concentration of a hazard in a food at the time of consumption that provides the appropriate level of protection (ALOP)[10].
Fresh Meat	Meat that apart from refrigeration has not been treated for the purpose of preservation other than through protective packaging and which retains its natural characteristics.
Game depot	A building in which killed wild game is temporarily held prior to transfer to an establishment, and which is approved, registered and/or listed by the competent authority for this purpose. (Note that for the purposes of this code, a game depot is a particular type of establishment).
Good Hygienic Practice (GHP)	All practices regarding the conditions and measures necessary to ensure the safety and suitability of food at all stages of the food chain[11].
Hazard	A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect[12].
Hunter	A person involved in the killing and/or bleeding, partial evisceration and partial field dressing of killed wild game.
Inedible	Examined and judged by a competent person, or otherwise determined by the competent authority to be unsuitable for human consumption.
Manufactured Meat	Products resulting from the processing of raw meat or from the further processing of such processed products, so that when cut, the cut surface shows that the product no longer has the characteristics of fresh meat.
Meat	All parts of an animal that are intended for, or have been judged as safe and suitable for, human consumption.
Meat hygiene	All conditions and measures necessary to ensure the safety and suitability of meat at all stages of the food chain.
Meat preparation	Raw meat which has had foodstuffs, seasonings or additives added to it.

[10] This is an interim definition for the purpose of this Code that is subject to change depending on the final outcome from CCFH.

[11] WHO Teachers Handbook, 1999

[12] Definitions for the Purpose of the Codex Alimentarius. Procedural Manual, 13th edition

Mechanically separated meat (MSM)	Product obtained by removing meat from flesh-bearing bones after boning or from poultry carcasses, using mechanical means that result in the loss or modification of the muscle fibre structure.
Minced meat	Boneless meat which has been reduced into fragments.
Official inspector	A competent person who is appointed, accredited or otherwise recognised by the competent authority to perform official meat hygiene activities on behalf of, or under the supervision of the competent authority.
Organoleptic inspection	Using the senses of sight, touch, taste and smell for identification of diseases and defects.
Performance criteria	The required outcome of one or more control measures at a step or a combination of steps that contribute to assuring the safety of a food[13].
Primary production	All those steps in the food chain constituting animal production and transport of animals to the abattoir, or hunting and transporting wild game to a game depot.
Process control	All conditions and measures applied during the production process that are necessary to achieve safety and suitability of meat[14].
Process criteria	The process control parameters (e.g. time, temperature, dose) at a specified step that can be applied to achieve performance criteria[15].
Post-mortem inspection[16]	Any procedure or test conducted by a competent person on all relevant parts of slaughtered/killed animals for the purpose of judgement of safety and suitability and disposition.
Quality assurance (QA)	All the planned and systematic activities implemented within the quality system and demonstrated as needed, to provide adequate confidence that an entity will fulfil requirements for quality[17].
Quality assurance (QA) system	The organisational structure, procedures, processes and resources needed to implement quality assurance.
Raw meat	Fresh meat, minced meat or mechanically separated meat[18].
Ready-to-Eat (RTE) products	Products that are intended to be consumed without any further biocidal steps.
Risk-based	Containing performance and/or process criteria developed according to risk analysis principles.

[13] This is an interim definition for the purpose of this Code that is subject to change depending on the final outcome from CCFH.
[14] The process includes ante- and post-mortem inspection.
[15] This is an interim definition for the purpose of this Code that is subject to change depending on the final outcome from CCFH.
[16] These and other procedures and tests stipulated by the Competent Authority may also be conducted, in particular for the purposes of animal health.
[17] ISO 8402
[18] This does not preclude interventions for the purpose of pathogen reduction.

Safe for human consumption	Safe for human consumption according to the following criteria: • has been produced by applying all food safety requirements appropriate to its intended end-use; • meets risk-based performance and process criteria for specified hazards; and • does not contain hazards at levels that are harmful to human health.
Sanitation standard operating procedures (SSOPs)	A documented system for assuring that personnel, facilities, equipment and utensils are clean and where necessary, sanitised to specified levels prior to and during operations.
Suitable for human consumption	Suitable for human consumption according to the following criteria: • has been produced under hygienic conditions as outlined in this code; • is appropriate to its intended use[19]; and • meets outcome-based parameters for specified diseases or defects as established by the competent authority.
Verification (Operator)	The continual review of process control systems, including corrective and preventative actions to ensure that regulatory and/or specified requirements are met.
Verification	Activities performed by the competent authority and/or competent body to determine compliance with regulatory requirements.
[Veterinary Inspector	An official inspector who is professionally qualified as a veterinarian and carries out officially meat hygiene activities as specified by the competent authority[20].]

4. GENERAL PRINCIPLES OF MEAT HYGIENE

Insert CAC/GL 50 (2003) adopted by the 26th Session of the Codex Alimentarius Commission (July 2003).
[The General Principles are given on page vii of this manual.]

5. PRIMARY PRODUCTION

14. Primary production is a significant source of hazards associated with meat. A number of hazards are present in animal populations intended for slaughter and their control during primary production, often presents considerable challenges, e.g., *E. coli* O157:H7, *Salmonella* spp., *Campylobacter* spp. and various chemical and physical hazards. A risk-based approach to meat hygiene includes consideration of risk management options that may have a significant impact on risk reduction when applied at the level of primary production[21].

15. Provision of relevant information on animals intended for slaughter facilitates application of risk-based meat hygiene programmes, and allows inspection procedures to be tailor-made to the

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[19] See for example the General Guidelines for Use of the Term "Halal" (CAC/GL 24-1997)
[20] These may include animal health objectives.
[21] Working Principles for Risk Analysis for Application in the Framework of the Codex Alimentarius, Procedural Manual, 13th edition

spectrum and prevalence of diseases and defects in the particular animal population. This may be particularly important in situations where the presence of zoonotic agents is not detectable by organoleptic or laboratory tests and routine precautionary measures need to be taken.

16. Voluntary or officially recognised QA systems implemented at primary production should be appropriately taken into account during verification of regulatory requirements.

17. The principles and guidelines presented in this section are supplemental to the objectives and guidelines in Section III of the Recommended International Code of Practice: General Principles of Food Hygiene (CAC/RCP 1-1969, Rev. 4-2003).

5.1 Principles of meat hygiene applying to primary production

i. Primary production should be managed in a way that reduces the likelihood of introduction of hazards and appropriately contributes to meat being safe and suitable for human consumption.
ii. Whenever possible and practicable, systems should be established by the primary production sector and the competent authority, to collect, collate and make available information on hazards and conditions that may be present in animal populations and that may affect the safety and suitability of meat.
iii. Primary production should include official or officially-recognised programmes for the control and monitoring of zoonotic agents in animal populations and the environment as appropriate to the circumstances, and notifiable zoonotic diseases should be reported as required.
iv. Good hygienic practice (GHP) at the level of primary production should involve, for example, the health and hygiene of animals, records of treatments, feedingstuffs and relevant environmental factors, and should include application of HACCP principles to the greatest extent practicable.
v. Animal identification practices should allow trace-back to the place of origin to the extent practicable, to allow regulatory investigation where necessary.

5.2 Hygiene of slaughter animals

18. Both primary producers and the competent authority should work together to implement risk-based meat hygiene programmes at the level of primary production that document the general health status of slaughter animals, and implement practices that maintain or improve that status, e.g., zoonoses control programmes. QA programmes at the level of primary production should be encouraged and may include application of HACCP principles as appropriate to the circumstances. Such programmes should be taken into account by the competent authority in the overall design and implementation of risk-based meat hygiene programmes.
So as to facilitate the application of risk-based meat hygiene programmes:

- Primary producers should record relevant information to the extent possible on the health status of animals as it relates to the production of meat that is safe and suitable for human consumption. This information should be made available to the abattoir as appropriate to the circumstances.
- Systems should be in place for return from the abattoir to the primary producer, of information on the safety and suitability of slaughter animals and meat, in order to improve the hygiene on the farm and, where producer-led QA-programmes are applied, to be incorporated into these programmes to improve their effectiveness.
- The competent authority should systematically analyse monitoring and surveillance information from primary production so that meat hygiene requirements may be modified if necessary.

19. The competent authority should administer an official programme for control of specified zoonotic agents, chemical hazards and contaminants. This should be co-ordinated to the greatest extent possible with other competent authorities that may have responsibilities in public and animal health.

Official or officially-recognised programmes for specified zoonotic agents should include measures to:

- control and eradicate their presence in animal populations, or subsets of populations, e.g., particular poultry flocks;
- prevent the introduction of new zoonotic agents;
- provide monitoring systems that establish baseline data and guide a risk-based approach to control of such hazards in meat; and
- control movement of animals between primary production units, and to abattoirs, where populations are under quarantine

Official or officially-recognised programmes for chemical hazards and contaminants should include measures to:

- control the registration and use of veterinary drugs and pesticides so that residues do not occur in meat at unsafe[22] levels that make the product unsafe for human consumption, and
- provide monitoring and surveillance systems that establish baseline data and guide a risk-based approach to control of such hazards in meat.

20. Animal identification systems, to the extent practicable, should be in place at primary production level so that the origin of meat can be traced back from the abattoir or establishment to the place of production of the animals.

21. Animals should not be loaded for transport to the abattoir when:

- the degree of contamination of the external surfaces of the animal is likely to compromise hygienic slaughter and dressing, and suitable interventions such as washing or shearing are not available,
- information is available to suggest that animals may compromise the production of meat that is safe and suitable for human consumption, e.g., presence of specific disease conditions or recent administration of veterinary drugs. In some situations, transport may proceed if the animals have been specifically identified (e.g. as suspects) and are to be slaughtered under special supervision; or
- animal stress issues may exist or arise that are likely to have an adverse impact on the safety and suitability of meat.

5.3 Hygiene of killed wild game

22. Only limited knowledge can be gained on the health status of populations of wild game hunted for meat; however, the competent authority should consider all sources when gathering such information. In this respect, hunters should be encouraged to provide relevant information, e.g., geographical origin of wild game, and any clinical symptoms of disease observed in wild animal populations.

23. Wild game should be harvested in a manner so that:

- killing methods are consistent with the production of meat that is safe and suitable for human consumption; and
- their geographical origin is not subject to relevant official prohibitions on harvest, e.g., in the case of concurrent chemical pest control programmes or animal health quarantine.

24. Hunters are particularly important in providing information on killed animals. They should be aware of their responsibilities in terms of supplying to the establishment, all relevant information that may impact on the safety and suitability of killed wild game meat, e.g., symptoms of disease

[22] Guidelines for the Establishment of a Regulatory Programme for Control of Veterinary Drug Residues in Foods (CAC/GL 16-1993) (under revision)

immediately before killing, grossly-apparent diseases and defects detected during partial field dressing and/or evisceration. The competent authority should require that hunters or other people involved in harvesting of wild game undergo basic training in meat hygiene appropriate to field procurement, e.g., recognition of diseases and defects, application of GHP in partial field dressing and transport to a game depot.

25. As wild game are killed in the field, appropriate hygienic practices immediately following death are essential to minimise contamination of edible parts. GHP should be applied to the extent practicable during bleeding, partial dressing, e.g., removal of the head, and/or partial evisceration (where allowed by the competent authority)[23].
Bleeding and partial dressing of killed wild game in the field should include:

- bleeding and partial evisceration as soon as possible after killing (unless exempted by the competent authority for a particular species of wild game);
- partial skinning and/or partial dressing in a manner that minimises the level of contamination of edible parts to the lowest level practicable;
- removal only of those parts of the animal that are not necessary for post-mortem inspection and judgement; and
- retention of the lungs, liver, heart and kidneys as a minimum if partial evisceration is carried out, either by natural attachment to the carcass or identified and packaged as an attachment to the carcass, unless a hunter, who is a competent person, has carried out an inspection and has not detected or suspected abnormalities[24].

26. Game depots should not be simultaneously used for a purpose other than receiving and holding killed wild game, unless the competent authority specifies other uses and conditions.

27. Delivery of killed wild game to a game depot or an establishment should be within time limits established by the competent authority considering harvesting, environmental conditions and desired food safety outcomes. The body and other animal parts should not be frozen before dressing and post-mortem inspection in an establishment, unless unavoidable due to ambient temperatures.

5.4 Hygiene of feedingstuffs[25]

28. Feeding of animals during primary production should be subject to good animal feeding practice in the procurement, handling, storage, processing and distribution of animal feedingstuffs, and in forage crop production and pasture feeding. Records should be maintained at the manufacturing level, on the origin of feedingstuffs and/or their ingredients to facilitate verification.

29. There is a need for collaboration between all parties involved in feed production, feed manufacturing and use so as to establish any linkage between identified hazards and the level of risk to consumers that may result from transmission through the food chain[26].
Animals should not be fed feedingstuffs that:

- are recognised as likely to introduce zoonotic agents (including TSEs) to the slaughter population; or

[23] Partial evisceration usually only involves removal of the gastrointestinal tract, and this aides cooling.
[24] In the case of small killed wild game, the competent authority may allow full evisceration.
[25] This section is subject to alignment with the Code of Practice on Good Animal Feeding (under development). See ALINORM 03/38A, Appendix II.
[26] OIE International Animal Health Code (chapters on zoonotic diseases); OIE Guidelines on antimicrobial resistance.

- contain chemical substances (e.g., veterinary drugs, pesticides) or contaminants that could result in residues in meat at levels that make the product unsafe for human consumption.

30. The competent authority should implement appropriate legislation and controls governing the feeding of animal protein to animals where there is a likelihood of transmission of zoonotic agents, and this may include a ban on such feeding when justified by risk management. Any processed feedingstuff should be subject to appropriate microbiological and other criteria, e.g., negative for *Salmonella* spp. according to a specified sampling plan, and maximum limits for mycotoxins.

5.5 Hygiene of the environment

31. Primary production of animals should not be undertaken in areas where the presence of hazards in the environment could lead to an unacceptable level of such hazards in meat.
The competent authority should design and administer monitoring and surveillance programmes appropriate to the circumstances, that address :

- hazards arising from animals and plants that may compromise the production of meat that is safe and suitable for human consumption;
- environmental contaminants that may result in levels in meat that make the product unsafe for human consumption; and
- ensuring that water and other potential carriers, e.g., fertilizer, are not significant vehicles for transmission of hazards.

Facilities and procedures should be in place to ensure that:

- housing and feeding platforms where used, and other areas where zoonotic agents and other hazards may accumulate, can be effectively cleaned, and are maintained in a sanitary condition (refer to Section 10);
- systems for active processing and/or disposal of dead animals and waste should not constitute a possible source of food-borne hazards to human and animal health; and
- chemical hazards required for technological reasons are stored in a manner so that they do not contaminate the environment or feedingstuffs.

5.6 Transport

5.6.1 Transport of slaughter animals

32. Transport of slaughter animals should be carried out in a manner that does not have an adverse impact on the safety and suitability of meat[27].
Slaughter animals require transport facilities to the abattoir that ensure that:

- soiling and cross-contamination with faecal material is minimised;
- new hazards are not introduced during transport;
- animal identification as to the place of origin is maintained; and
- consideration is given to avoiding undue stress.

Transport vehicles should be designed and maintained so that:

- animals can be loaded, unloaded and transported easily and with minimal risk of injury;
- animals of different species, and animals of the same species likely to cause injury to one another, are physically separated during transport;
- use of floor gratings, crates or similar devices limits soiling and cross-contamination with faecal material;

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[27] OIE International Animal Health Code (chapter on transport); Report of the OIE Working Group on Animal Welfare, October 2002.

- where the vehicle has more than one deck, animals are protected from cross-contamination as appropriate ;
- ventilation is adequate; and
- cleaning and sanitising is readily achieved (refer to Section 10).

33. Transport vehicles, and crates where used should be cleaned and if necessary sanitised as soon as practicable after animals have been unloaded at the establishment.

5.6.2 Transport of killed wild game

34. Following killing and dressing in the field, the body and other parts should be transported to an establishment, including a game depot, without delay and in a manner that minimises contamination of edible parts. Vehicles used for this purpose should be consistent with good hygienic practice and any specific regulatory requirements.

35. Unless deemed unnecessary due to low environmental ambient temperatures, the temperature of the body should be actively reduced as quickly as possible after partial field dressing and transport.

6. PRESENTATION OF ANIMALS FOR SLAUGHTER

36. Only healthy, clean and appropriately identified animals should be presented for slaughter.

37. Ante-mortem inspection is an important pre-slaughter activity, and all relevant information on animals presented for slaughter should be utilised in meat hygiene systems.

6.1 Principles of meat hygiene applying to animals presented for slaughter

i. Animals presented for slaughter should be sufficiently clean so that they do not compromise hygienic slaughter and dressing.
ii. The conditions of holding of animals presented for slaughter should minimise cross-contamination with food-borne pathogens and facilitate efficient slaughter and dressing.
iii. Slaughter animals should be subjected to ante-mortem inspection, with the competent authority determining the procedures and tests to be used, how inspection is to be implemented, and the necessary training, knowledge, skills and ability of personnel involved.
iv. Ante-mortem inspection should be science- and risk-based as appropriate to the circumstances, and should take into account all relevant information from the level of primary production.
vi. Relevant information from primary production where available and results of ante-mortem inspection should be utilised in process control.
vi. Relevant information from ante-mortem inspection should be analysed and returned to the primary producer as appropriate.

6.2 Conditions of lairage

38. Holding of animals presented for slaughter has an important effect on many aspects of slaughter, dressing and the production of meat that is safe and suitable for human consumption. The cleanliness of animals has a major influence on the level of microbiological cross-contamination of the carcass and other edible parts during slaughter and dressing. A range of measures appropriate to the animal species may be applied to ensure that only animals that are sufficiently clean are slaughtered and to assist in reducing microbiological cross- contamination.

39. QA systems implemented by the establishment operator should enhance achievement of appropriate conditions of lairage on an on-going basis.

The establishment operator should ensure conditions of lairage that include:

- facilities are operated in a way that soiling and cross-contamination of animals with food-borne pathogens are minimised to the greatest extent practicable;
- holding of animals so that their physiological condition is not compromised and ante-mortem inspection can be effectively carried out, e.g., animals should be adequately rested and not overcrowded and protected from weather where necessary;
- separation of different classes and types of slaughter animals as appropriate, e.g., sorting of animals by age so as to facilitate the efficiency of routine dressing, separation of animals with special dressing requirements, and separation of suspects that have been identified as having the potential to transfer specific food-borne pathogens to other animals (refer to 6.3);
- systems to ensure that only animals that are sufficiently clean are slaughtered;
- systems to ensure that feed has been appropriately withdrawn before slaughter;
- maintenance of identification of animals (either individually, or as lots, e.g., poultry) until the time of slaughter and dressing; and
- conveying of relevant information on individual animals or lots of animals to facilitate ante- and post-mortem inspection.

40. The competent authority or the competent body should take into account QA systems properly implemented by the establishment operator, in setting the frequency and intensity of verification activities necessary to determine that the conditions of lairage are in accordance with regulatory requirements.

6.3 Ante-mortem inspection

41. All animals presented for slaughter should be subjected to ante-mortem inspection, by a competent person whether on an individual or a lot basis. Inspection should include confirmation that the animals are properly identified, so that any special conditions pertaining to their place of primary production are considered in the ante-mortem inspection, including relevant public and animal health quarantine controls.

42. Ante-mortem inspection should support post-mortem inspection by application of a specific range of procedures and/or tests that consider the behaviour, demeanour and appearance, as well as signs of disease in the live animal.

43. Ante-mortem inspection should be preceded by screening of animals by the establishment operator upon their arrival at the abattoir. Where abnormalities in behaviour or appearance suggest that an individual animal or a consignment of animals should be segregated, this should occur and the competent person undertaking ante-mortem inspection, notified.
Animals described below should be subject to special controls, procedures or operations imposed by the competent authority (which may include denial of entry to the abattoir) when:

- animals are not sufficiently clean;
- animals have died in transit;
- a zoonotic disease posing an immediate threat to either animals or humans is present, or suspected;
- an animal health disease subject to quarantine restrictions is present, or suspected;
- animal identification requirements are not met; or
- declarations from the primary producer, if required by the competent authority (including compliance with good veterinary practice in the use of animal medicines), are absent or inadequate.

6.3.1 Design of ante-mortem inspection systems

44. Ante-mortem inspection should be included as an integral component of an overarching risk-based system for the production of meat, with systems for process control (refer to Section 9)

incorporating appropriate components. Relevant information on the slaughter population, e.g., animal class, health status, geographical region of origin, should be utilised in both the design and implementation of ante-mortem inspection systems.

45. Ante-mortem inspection, including procedures and tests, should be established by the competent authority according to a science and risk-based approach. In the absence of a risk-based system, procedures will have to be based on current scientific knowledge and practice.

46. Ante-mortem procedures and tests may be integrated and implemented together so as to achieve public health and animal health objectives. In such cases all aspects of ante-mortem inspection should be science-based and be tailored to the relevant risks.

47. Where indicated by public health concerns, measures additional to routine ante-mortem inspection may be required.

Characteristics of a risk-based ante-mortem inspection programme are:

- procedures for confirmation of proper animal identification in accordance with national legislation;
- design and application of organoleptic procedures and tests that are relevant and proportional to meat-borne risks associated with clinical signs of illness and grossly-detectable abnormalities;
- tailoring of procedures to the spectrum and prevalence of diseases and defects reasonably likely to be present in the slaughter population, taking into account the type of animal, geographical origin and primary production system;
- integration with HACCP-based process control to the extent practicable, e.g., application of objective criteria for ensuring appropriate cleanliness of animals presented for slaughter;
- on-going tailoring of procedures to information received from the primary production unit, where practicable;
- use of laboratory tests for hazards that are unaddressed by organoleptic inspection when their presence is suspected, e.g., chemical residues and contaminants; and
- return of information to the primary producer so as to seek continuous improvement in the safety and suitability status of animals presented for slaughter (refer to 6.4).

6.3.2 Implementation of ante-mortem inspection

48. The competent authority should determine how ante-mortem inspection is to be implemented, including identification of the components that may be applied at primary production rather than the abattoir, e.g., in the case of intensively-raised poultry[28]. The competent authority should establish the training, knowledge, skills and ability requirements of all personnel involved, and the roles of the official inspector, including the veterinary inspector (refer to 9.2). Verification of inspection activities and judgements should be undertaken as appropriate by the competent authority or competent body. The final responsibility for verifying that all regulatory requirements are met should lie with the competent authority.

The responsibilities of the establishment operator in respect of ante-mortem inspection include:

- presentation of a certificate to the competent person undertaking ante-mortem inspection, stating that animals have passed ante-mortem inspection when this has been carried out at the primary production unit;
- segregation of animals if, for example, they have recently given birth during transport or in lairages, or have recently aborted and/or show retained foetal membranes;
- applying identification systems for individual animals or lots of animals until the time of slaughter that document the outcome of ante-mortem inspection, and after slaughter in the case of suspect animals;

[28] In some cases the competent authority may allow slaughter on the farm for particular classes of animal, e.g., farmed game, and in such cases the slaughter animals should be subject to ante-mortem inspection and other hygiene controls as determined by the competent authority.

- presentation of animals that are sufficiently clean; and
- prompt removal of animals that have died in the lairage, e.g., from metabolic disease, stress, suffocation, with the permission of the competent person undertaking ante-mortem inspection.

49. Ante-mortem inspection at the abattoir should occur as soon, as is practicable after delivery of slaughter animals. Only animals that are judged to be sufficiently rested should proceed to slaughter, but should not be withheld from slaughter any longer than necessary. Where there is an undue delay before slaughter, e.g., more than 24 hours, ante-mortem inspection should be repeated.

Ante-mortem inspection systems required by the competent authority should include the following:

- all relevant information from the level of primary production should be taken into account on an on-going basis, e.g., declarations from the primary producers relating to the use of veterinary drugs, information from official hazard control programmes;
- animals suspected as being unsafe or unsuitable for human consumption should be identified as such and handled separately from normal animals (refer to 6.2 and 8.2);
- results of ante-mortem inspection are made available to the competent person undertaking post-mortem inspection before animals are examined at the post-mortem stations so as to augment final judgement. This is particularly important when a competent person undertaking ante-mortem inspection, judges that a suspect animal can proceed to slaughter under special hygiene conditions;
- in more equivocal situations, the competent person undertaking ante-mortem inspection may hold the animal (or lot) in special facilities for more detailed inspection, diagnostic tests, and/or treatment;
- animals condemned as unsafe or unsuitable for human consumption should be immediately identified as such and handled in a manner that does not result in cross-contamination of other animals with food-borne hazards (refer to 8.2); and
- the reason for condemnation should be recorded, with confirmatory laboratory tests being carried out if deemed necessary. Feed back of this information to the primary producer should take place.

50. Slaughter of animals under an official or officially-recognised programme for the eradication or control of a specific zoonotic disease, e.g., salmonellosis, should only be carried out under the hygiene conditions specified by the competent authority.

6.3.3 Ante-mortem judgement categories

Ante-mortem judgement categories include:

- passed for slaughter;
- passed for slaughter subject to a second ante-mortem inspection, after an additional holding period, e.g., when animals are insufficiently rested, or are temporarily affected by a physiological or metabolic condition;
- passed for slaughter under special conditions i.e. deferred slaughter as suspects , where the competent person undertaking ante-mortem inspection suspects that post-mortem inspection findings could result in partial or total condemnation;
- condemned for public health reasons i.e. due to: meat-borne hazards, occupational health hazards, or likelihood of unacceptable contamination of the slaughter and dressing environment following slaughter[29];
- condemned for meat suitability reasons;
- emergency slaughter, when an animal eligible for being passed under special conditions could deteriorate if there was a delay in slaughter; and

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[29] The competent person may judge, after post-mortem inspection in special facilities, that edible parts of the animal can be salvaged for a particular purpose e.g. pet-food.

- condemned for animal health reasons, as specified in relevant national legislation, and disposed of accordingly.

6.4 Information on animals presented for slaughter

51. Information provided on animals presented for slaughter may be an important determinant of optimal slaughter and dressing procedures and is a prerequisite for effective design and implementation of process control by the establishment operator. The competent authority should analyse relevant information and take it into account when setting hygiene requirements for risk-based hygiene systems throughout the entire food chain (refer to 9.2).

52. The competent authority may require monitoring of animals presented for slaughter to establish baseline information on the prevalence of hazards in the slaughter population, e.g., specified meat-borne pathogens, chemical residues greater than maximum residue limits. The competent authority should design and implement these monitoring activities according to national public health goals. Scientific analysis and dissemination of results to interested parties is the responsibility of the competent authority. So as to facilitate science- and risk-based meat hygiene throughout the entire food chain, systems should be in place that provide:

- on-going information on animals presented for slaughter for incorporation into HACCP plans and/or QA programmes that are part of process control;
- information back to the primary producer on the safety and suitability status of animals presented for slaughter; and
- information to the competent authority that facilitates on-going review.

7. PRESENTATION OF KILLED WILD GAME FOR DRESSING

53. Killed wild game presented at an establishment have been subject to different harvesting, handling and transportation arrangements compared to live animals presented for slaughter. Killed wild game should undergo an appropriate inspection before dressing and full post-mortem inspection commences, so as to prevent undue contamination of the dressing environment and wastage of resources.

7.1 Principles of meat hygiene applying to inspection of killed wild game presented for dressing

i. Inspection of killed wild game for safety and suitability prior to dressing should be risk-based to the extent practicable, and should take into account relevant information available from the field.

7.2 Inspection of killed wild game presented for dressing

54. The inspection should determine to the extent possible whether hygienic practice for field-harvested animals has been appropriately applied, including an assessment of cleanliness sufficient for hygienic dressing. Special measures required by the competent authority to facilitate post-mortem inspection, e.g., correct identification and attachment of viscera separated from the carcass (refer to 5.3), should be confirmed at this time.

55. The inspection should take into account any information available from harvesting in the field, e.g., presence of abnormalities at the time of death, geographical location. Where practicable, the results should be returned to hunters or other people involved in harvesting of wild game so as to improve their knowledge of and contribution to meat hygiene.

56. Inspection of killed wild game for safety and suitability prior to dressing should be risk-based to

the extent practicable, given that the entire animal may not be presented for dressing, e.g., the gastrointestinal tract of large killed wild game will most likely have been discarded in the field. Inspection procedures prior to dressing and post-mortem inspection, will be necessarily limited in nature. They should be focused on detecting abnormalities intrinsic to field harvesting of wild game, e.g. signs of natural death or the animal being moribund at the time of death, the effects of a misplaced or expanding bullet, decomposition, and any evidence of intoxication with poisons or environmental contaminants. Systems for the implementation of inspection procedures and judgements should be based on those used for ante-mortem inspection of other classes of animals (refer to 6.3).

57. Identity of the body of the animal along with those parts required for post-mortem inspection, should be maintained until final post-mortem judgement.

8. ESTABLISHMENTS: DESIGN, FACILITIES AND EQUIPMENT

58. The principles and guidelines presented in this section are supplemental to the objectives and guidelines in Section IV of the Recommended International Code of Practice: General Principles of Food Hygiene (CAC/RCP 1-1969, Rev 4 2003).

59. The competent authority should allow variations in the design and construction of game depots and establishments processing killed wild game, and their facilities, where they are by necessity impermanent, as long as meat hygiene is not compromised.

8.1 Principles of meat hygiene applying to establishments, facilities and equipment

i. Establishments should be located, designed and constructed so that contamination of meat is minimised to the greatest extent practicable.
ii. Facilities and equipment should be designed, constructed and maintained so that contamination of meat is minimised to the greatest extent practicable.
iii. Establishments, facilities and equipment should be designed to allow personnel to carry out their activities in a hygienic manner.
iv. Facilities and equipment that are in direct contact with edible parts of animals and meat should be designed and constructed so that they can be effectively cleaned and monitored for their hygiene status.
v. Suitable equipment should be available for control of temperature, humidity and other factors as appropriate to the particular processing system for meat.
vi. Water should be potable except where water of a different standard can be used without leading to contamination of meat.

60. Each establishment should have appropriate facilities and equipment for competent persons to properly carry out their meat hygiene activities.

61. Laboratory facilities necessary to support meat hygiene activities may be located in the establishment or provided at a separate location.

8.2 Design and construction of lairages

62. Lairages should be designed and constructed so that they do not lead to undue soiling of the animal, cause undue stress of the animal, or otherwise adversely impact on the safety and suitability of meat derived from animals held therein.
Lairages should be designed and constructed so that:

- animals can be held without overcrowding or injury, and are not exposed to climatic stress[30];
- there are appropriate layout and facilities for cleaning and/or drying of animals;
- ante-mortem inspection is facilitated;
- floors are paved or slatted and allow good drainage;
- there is an adequate supply and reticulation of clean water for drinking and cleaning, and facilities are provided for feeding where necessary;
- there is a physical separation between lairages and areas of an abattoir where edible material may be present;
- Suspect animals can be segregated and examined in separate areas[31]. These areas should include facilities that are capable of secure holding of suspect animals pending slaughter under supervision, in a manner that precludes contamination of other animals; and
- there is an adjacent area with adequate facilities for cleaning and sanitation of transport vehicles and crates, unless there are facilities within close distance that are approved by the competent authority.

63. Special facilities may be required to handle condemned animals.
These facilities should be:

- constructed so that all parts, gut contents and faeces from condemned animals can be held under secure containment as appropriate to the circumstances; and
- constructed and equipped so as to facilitate effective cleaning and sanitation (refer to Section 10).

8.3 Design and construction of slaughter areas

64. Stunning and bleeding areas should be separated from dressing areas (either physically or by distance), so that cross-contamination of animals is minimised.

65. Areas for scalding, dehairing, defeathering, scraping and singeing (or similar operations) should also be appropriately separated from dressing areas.

66. Where slaughter is carried out the processing line should be designed so that there is constant progress of animals in a manner that does not cause cross-contamination.

67. Special facilities may be required to slaughter and dress suspect or injured animals.
Where these facilities exist they should be:

- easily accessed from pens containing suspect or injured animals;
- constructed with suitable facilities for hygienic storage of parts derived from suspect or injured animals; and
- constructed and equipped so as to facilitate effective cleaning and sanitising (refer to Section 10).

8.4 Design and construction of areas where bodies of animals are dressed or meat may otherwise be present

68. All areas and facilities where bodies of animals are dressed or meat may be present should be designed and constructed so that they allow GHP[32], and contamination of meat is minimised to the greatest extent practicable.

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30 In the case of poultry and farmed game birds, facilities should be available to park transport vehicles in areas that are well ventilated, and are protected from direct sunlight, inclement weather and extremes of temperature.

31 In the case of poultry and farmed game birds, suspect birds are usually slaughtered on the slaughter line under special hygiene provisions.

32 Recommended International Code of Practice: General Principles of Food Hygiene (CAC/RCP 1 - 1969, Rev. 4-2003)

Rooms and other areas in which bodies of animals are dressed or meat may be present should be designed and constructed so that:

- cross-contamination during operations is minimised to the greatest extent practicable;
- effective cleaning, sanitation and maintenance can be carried out during and between periods of operation; (refer to Section 10);
- floors in areas where water is present slope sufficiently to grilled or otherwise protected outlets so as to ensure continual drainage;
- exterior doors do not open directly into the area;
- chutes separately conveying different parts of animals are fitted with inspection and cleaning hatches where these are necessary for sanitation;
- separate rooms or separated areas are used for skin-on dressing of pigs or other animals, when other classes of animals are being dressed at the same time;
- separate rooms are used for:
  - emptying and cleansing of alimentary tracts, and further preparation of clean alimentary tracts, unless such separation is deemed unnecessary;
  - handling of meat and inedible parts of animals after they have been so designated, unless these products are otherwise separated by time or distance;
  - storage of inedible animal parts such as hides, horns, hooves, feathers and inedible fats;
- there is adequate natural or artificial lighting for hygienic process control;
- there are appropriate facilities for the preparation and storage of edible fats;
- access and harbouring of pests are effectively restricted; and
- adequate facilities are provided for secure storage of chemicals, (e.g., cleaning materials, lubricants, branding inks) and other hazardous substances so as to prevent accidental contamination of meat.

69. Appropriately designed and insulated rooms should be available as necessary for cooling, chilling and freezing of meat.
Establishments that de-bone or otherwise cut up meat should have for this purpose:

- facilities that allow constant progress of operations or that ensure separation between different production batches;
- a room or rooms, capable of being temperature-controlled; and
- separation of the boning, cutting and primary wrapping area from the packaging area, unless hygiene measures are in place to ensure that packaging does not contaminate meat.

70. Wood may be used in rooms for curing, smoking, maturing, pickling, storage and dispatch of meat preparations and manufactured meat when essential for technological reasons, as long as meat hygiene requirements are not compromised

71. Drainage and waste disposal systems should not be a source of contamination of meat, the potable water supply or the processing environment. All lines should be watertight and adequately trapped and vented, with catch basins, traps and sumps that are isolated from any area where animals are dressed or meat may be present.

72. Establishments should have an appropriate area, sufficiently protected from environmental contamination and capable of preventing adverse temperature variations, for dispatching meat.

8.5 Design and construction of equipment where bodies of animals are dressed or meat may be present

73. All equipment used in areas where bodies of animals are dressed or meat may be present should facilitate GHP. Equipment and containers in rooms and other areas where bodies of animals are dressed or meat may be present should be designed and constructed so that contamination is

minimised. Meat should not be allowed to contact the floor and walls, or fixed structures not designed for such contact.

74. Where slaughter lines are operated, they should be designed so that there is constant progress of animal bodies, carcasses and other parts, in a manner that prevents cross-contamination between different parts of the slaughter line and between different slaughter lines. In establishments where meat preparations and manufactured meat are circulating, the layout and equipment should be designed to prevent cross contamination between products of different status and products at different production stages.

75. All rooms and other areas in which animals are dressed or meat may be present should be equipped with adequate facilities for washing hands, and should be equipped with adequate facilities for cleaning and sanitation of implements where required (refer to Section 10).
Facilities for cleaning and sanitation of equipment should:

- be designed to effectively clean and sanitise the particular equipment;
- be located convenient to work stations; and
- have waste water ducted to drains.

76. Equipment and implements for use with inedible or condemned parts of animals should be distinctively identified.

77. Establishments should be provided with adequate means of natural or mechanical ventilation so as to prevent excessive heat, humidity and condensation, and ensure that air is not contaminated with odours, dust or smoke.
Ventilation systems should be designed and constructed so that:

- air-borne contamination from aerosols and condensation droplets is minimised;
- ambient temperatures, humidity and odours are controlled; and
- air flow from contaminated areas (e.g., slaughter and dressing areas) to clean areas, (e.g., chilling rooms for carcasses) is minimised.

78. Equipment used for heat treatment of manufactured meat and meat preparations should be fitted with all control devices necessary to ensure that an appropriate heat treatment is applied.

8.6 Water supply[33]

79. Adequate facilities should be provided for monitoring and maintaining potability, storage, temperature control, distribution of water and for the disposal of waste water.
Equipment should be installed that provides:

- an adequate and easily accessible supply of hot and cold potable water at all times;
- hot potable water for effective sanitising of equipment, or an equivalent sanitation system;
- potable water at a temperature appropriate for hand-washing; and
- sanitising solution used according to manufacturers' specifications supplied as and where necessary.

80. Where non-potable water is supplied for various uses e.g., fire fighting, steam production, refrigeration, reticulation systems should be designed so that cross-contamination of the potable water supply is prevented.

[33] General Principles of Food Hygiene, Section 5.5 (CAC/RCP 1-1969, Rev. 4-2003).

8.7 Temperature control

81. In the absence of suitable temperature, humidity and other environmental controls, meat is particularly vulnerable to survival and growth of pathogens and spoilage micro-organisms.

82. Facilities and equipment should be adequate for:
- Cooling, chilling and/or freezing of meat according to written specifications;
- Storage of meat at temperatures that achieve the safety and suitability requirements; and
- Monitoring of temperature, humidity, air flow and other environmental factors so as to assure that process control regimes are achieved.

83. Where steam is generated in the cooking of meat, it should be properly vented out of the area in order to minimise the potential for condensation and not be allowed to permeate into adjoining rooms.

8.8 Facilities and equipment for personal hygiene

84. Slaughter and dressing of animals and animal parts, and further handling of meat preparations and manufactured meat presents many opportunities for cross-contamination of meat by food handlers (refer to Section 11). Appropriate personal hygiene facilities are needed to minimise cross-contamination of meat from this source.

85. Facilities and equipment should be provided, designed and located so that meat safety is not compromised. Where necessary, separate amenities should be provided e.g. for staff handling live animals, condemned products (refer Section 11).
Facilities for personal hygiene should include:
- changing rooms, showers, flush toilets, hand-washing and hand-drying facilities where necessary, and separate areas for eating; and
- protective clothing that can be effectively cleaned and minimises accumulation of contaminants.

All areas in which exposed meat may be present, should be equipped with adequate facilities for washing hands that:
- are located convenient to work stations;
- have taps that are not operable by hand;
- supply water at an appropriate temperature, and are fitted with dispensers for liquid soap or other hand cleansing agents;
- include hand drying equipment where necessary, and receptacles for discarded paper towels; and
- have waste water ducted to drains.

8.9 Means of transport

Vehicles or shipping containers in which unprotected meat is transported should:
- be designed and equipped so that the meat does not contact the floor;
- have joint and door seals that prevent entry of all sources of contamination; and
- where necessary, be equipped so that temperature control and humidity can be maintained and monitored.

9. PROCESS CONTROL

86. An extensive range of hazards are associated with meat, e.g., *Salmonella* spp. and veterinary drug residues; the processing environment, e.g., *Listeria monocytogenes* and *Clostridium*

perfringens; and food handlers themselves, e.g., *Staphylococcus aureus* and hepatitis viruses. Effective process control, that includes both GHP and HACCP, is necessary to produce meat that is safe and suitable for human consumption.

87. The principles and guidelines presented in this section should satisfy the general objectives and guidelines in Section V of the Recommended International Code of Practice: General Principles of Food Hygiene (CAC/RCP 1-1969, Rev 4-2003). They are developed in this section in respect of hazards in meat however they are equally applicable to suitability characteristics.

88. Many aspects of slaughter and dressing procedures have the potential to result in significant contamination of meat, e.g., hide/feather removal, evisceration, carcass washing, post-mortem inspection, trimming, and further handling in the cold chain. Systems for process control should limit microbial cross-contamination in these circumstances to as low as practicably achievable, and reflect the proportional contribution of these controls in reducing meat-borne risks to human health.

89. Ready-to-eat (RTE) products may require specific microbiological testing regimes that incorporate microbiological performance criteria, process criteria and/or microbiological criteria.

9.1 Principles of meat hygiene applying to process control

i. Production of meat that is safe and suitable for human consumption requires that detailed attention be paid to the design, implementation, monitoring and review of process control.
ii. The establishment operator has the primary responsibility for implementing systems for process control. Where such systems are applied, the competent authority should verify that they achieve all meat hygiene requirements.
iii. Process control should limit the level of microbiological contamination to the lowest level practicable, according to a risk-based approach.
iv. HACCP should be applied wherever practicable as the system of choice for process control, and should be supported by prerequisite GHP that includes SSOPs.
v. Process control should reflect an integrated strategy for control of hazards throughout the food chain, with information available from primary production and pre-slaughter being taken into account wherever possible and practicable.
vi. All bodies of animals should be subjected to post-mortem inspection that is science- and risk-based, and is tailored to the hazards and/or defects that are reasonably likely to be present in the bodies of animals presented for inspection[34].
vii. The competent authority should determine the procedures and tests to be used in post-mortem inspection, how that inspection is to be implemented, and the necessary training, knowledge, skills and ability required of personnel involved (including the role of veterinarians, and personnel employed by the establishment operator).
viii. Post-mortem inspection should take into account all relevant information from primary production, ante-mortem inspection, and from official or officially-recognised hazard control programmes.
ix. Post-mortem judgements should be based on: food-borne risks to human health, other human health risks, e.g., from occupational exposure or handling of meat in the home, food-borne risks to animal health as specified in relevant national legislation, and suitability characteristics.
x. Performance criteria for the outcome of process control and post-mortem inspection activities should be established by the competent authority wherever practicable, and should be subject to verification by the competent authority.

[34] Where risk assessment capability is not available, post-mortem inspection carried out according to current scientific knowledge and practice should be capable of achieving the level of consumer protection required.

xi. Where appropriate, microbiological testing, for verification purposes, should be included in meat preparation and manufactured meat HACCP plans. Such testing should be relevant to the type of product and the likely risks to consumers, including vulnerable sub-populations.
xii. Competent bodies or competent persons may be engaged by the establishment operator to undertake prescribed process control activities[35], including ante-[36] and post-mortem inspection, as approved by the competent authority.
xiii. Handling of RTE products up until the point of sale to the consumer should ensure that there is no contact with non-RTE products, and any other exposure to potential sources of microbiological contamination is minimised to the greatest extent practicable.
xiv. Voluntary or officially recognised QA systems may be implemented by the establishment operator where they enhance meat hygiene activities, and they may be taken into account in the verification of regulatory requirements by the competent authority.

9.2 Process control systems

90. Effective process control requires design and implementation of appropriate systems. Industry has the primary responsibility for applying and supervising process control systems to ensure the safety and suitability of meat, and these should incorporate prerequisite GHP and HACCP plans as appropriate to the circumstances.

91. A documented process control system should describe the meat hygiene activities applied (including any sampling procedures), performance criteria (if set), verification activities, and corrective and preventative actions.

92. Competent bodies or competent persons suitably recognised by the competent authority may be engaged by the establishment operator to undertake prescribed process control activities, including post-mortem inspection. These activities should be part of HACCP or QA systems as appropriate to the circumstances.

93. Process control systems relating to food safety should incorporate a risk-based approach. Application of HACCP principles in the design and implementation of process control systems should be according to The Hazard Analysis and Critical Control Point (HACCP) System and Guidelines for its Application (CAC/RCP 1-1969, Rev. 4-2003). The Guidelines for the Design, Operation, Assessment and Accreditation of Food Import and Export Inspection and Certification Systems (CAC/GL 26-1997) provide general requirements for control of operations for food as they relate to international trade.

9.2.1 Sanitation Standard Operating Procedures (SSOPs)

94. Pre-operational and operational SSOPs should minimise direct and indirect contamination of meat to the greatest extent possible and practicable. A properly implemented SSOP system should ensure that facilities and equipment are clean and sanitised prior to start of operations, and appropriate hygiene is maintained during operations. SSOP guidelines may be provided by the competent authority, which may include minimum regulatory requirements for general sanitation.
Characteristics of SSOPs are:

- development of a written SSOP programme by the establishment that describes the procedures involved and the frequency of application;
- identification of establishment personnel responsible for implementing and monitoring SSOPs;
- documentation of monitoring and any corrective and/or preventative actions taken, which is made available to the competent authority for purposes of verification;

[35] Prescribed process control activities may include Officially recognised inspection systems (CAC/GL 20 - 1995)
[36] Ante-mortem inspection as covered in Section 6.3

- corrective actions that include appropriate disposition of product; and
- periodic evaluation of the effectiveness of the system by the establishment operator.

95. Microbiological verification of SSOPs can utilise a range of direct or indirect methods. Establishment operators should use statistical process control or other methods to monitor sanitation trends.

96. In the case of RTE products, microbiological verification of SSOPs for food contact and non-food contact surfaces is likely to be of higher intensity than for other types of product.

9.2.2 HACCP

97. HACCP systems for production of meat are a proactive means of process control for food safety purposes[37]. Validation of a HACCP plan for meat should ensure that it is effective in meeting performance criteria (refer 9.2.3), taking into account the degree of variability in presence of hazards that is normally associated with different lots of animals presented for processing.

98. Verification frequency may vary according to the operational aspects of process control, the historical performance of the establishment in application of the HACCP plan, and the results of verification itself. The competent authority may choose to approve HACCP plans and stipulate verification frequencies.

99. Microbiological testing for verification of HACCP systems, e.g. for verification of critical limits and statistical process control, is an important feature of HACCP.

100. Guidelines for the development of HACCP programmes to achieve pre-determined process criteria stipulated by the competent authority should be provided to establishment operators so as to guide development of process and product-specific HACCP plans. Guidelines should be developed in consultation with industry and other interested stakeholder organisations, and may be differentiated according to processing category, e.g.:

- Raw ground or comminuted e.g. pork sausage
- Meat with secondary inhibitors / non-shelf stable e.g. cured corned beef
- Heat treated / not fully cooked, non-shelf stable e.g. partially-cooked patties
- Fully cooked / non-shelf stable e.g. cooked ham
- Non-heat treated / shelf stable e.g. dry salami
- Heat treated / shelf stable e.g. beef jerky
- Thermally processed / commercially sterile e.g. canned meat
- Specific ethnic processes, e.g. tandoori

101. When developing HACCP plans for heat-treated meat preparations and manufactured meat, the establishment operator should fully document as appropriate to the process, all thermal process parameters, post-heat treatment handling, and additional preservation treatments appropriate to the intended process outcome e.g. pasteurisation. Process parameters for cooling of heat-treated products may incorporate as appropriate to the product, rapid cooling, slow cooling, or interrupted cooling. Previously heated products should not be packaged above a minimum temperature, e.g. 4 C, unless it can be demonstrated that cooling after packaging does not compromise product safety.

102. HACCP plans for meat preparations and manufactured meat that are cooked should include monitoring and documentation of parameters that ensure appropriate internal temperatures are

[37] Hazard Analysis and Critical Control Point (HACCP) System and Guidelines for its Application, (Annex to CAC/RCP 1-1969, Rev. 4-2003)

reached. Internal temperatures of product should be taken as necessary to verify the adequacy of the cook.

9.2.3 Outcome-based parameters for process control

103. In a risk-based meat hygiene system, verification of process control is greatly strengthened by establishment of performance criteria for the outcome of specified activities. In most cases these will be established by the competent authority. When performance criteria are established, industry can use them to readily demonstrate adequate process control for food safety characteristics of meat.

104. The establishment should have a documented process control system for implementing corrective actions that will allow it to consistently meet performance criteria. Process review and any other corrective and preventative actions required as a result of non-compliance with performance criteria should be properly recorded. The competent authority should implement a system for collecting and analysing results from all establishments to the greatest extent possible, and periodically review process control trends in relation to national meat hygiene goals.

105. Where possible, performance criteria should objectively express the level of hazard control as derived from the application of risk analysis principles. In the absence of sufficient knowledge of risks to human health, performance criteria can initially be established from baseline surveys of current performance, and subsequently modified as appropriate to reflect public health goals. Where outcome-based parameters have been established for suitability characteristics of meat, outcomes should be practically achievable and reflect consumer expectations.

106. Organoleptic parameters may also be established e.g., zero tolerance for visible faecal contamination on carcasses.

Performance criteria for outcomes of process control systems act to:

- facilitate validation of process control systems;
- facilitate derivation of process parameters at various steps in the food production system;
- allow maximum flexibility and technical innovation in the way the establishment operator achieves the required level of performance;
- facilitate industry-wide consistency in performance;
- provide an objective basis for outcome-driven regulatory guidelines and standards, e.g., statistical process control requirements, prevalence of *Salmonella* spp.;
- improve hazard control over time so as to enhance the level of consumer protection; and
- facilitate determination of the equivalence of sanitary measures.

107. Microbiological performance criteria, process criteria and microbiological criteria for RTE products should be risk-based according to the category of product e.g. not heat treated and shelf stable, heat treated and shelf stable, fully cooked and not shelf stable. Microbiological verification tests should be undertaken by the establishment at a frequency appropriate to the circumstances. The competent authority may also implement testing to verify that appropriate control is maintained by industry. HACCP plans applied by the establishment should document corrective and preventative measures to be taken in the event of positive tests for pathogens or toxins.

108. Where performance criteria are established as regulatory requirements, explanation of the linkage to an appropriate level of consumer protection should be provided to all interested parties, e.g., guidelines for allowable levels of generic *E. coli*, standards for absence of *E. coli* O157:H7, maximum residue limits for chemicals with acute toxicity.

109. In some circumstances a performance criterion may be established as a microbiological criterion that defines the acceptability of a production lot, e.g. based on the presence/absence or number of

microbes, and/or the quantity of their toxins or metabolytes according to a specified sampling plan[38].

110. Performance criteria for outcomes of process control may be difficult to establish for some hazards of concern, and the competent authority may need to implement specific procedures and tests to achieve expected levels of consumer protection, e.g. BSE. Specific measures such as these should be implemented on the basis of risk assessment and full consideration of the effectiveness of all available risk management options[39].

111. The competent authority should, wherever practicable, recognise different risk-based meat hygiene activities within its competence, which have been demonstrated to meet at least the same risk-based meat hygiene outcomes.

9.2.4 Regulatory systems

112. The competent authority should have the legal power to set and enforce regulatory meat hygiene requirements, and has the final responsibility for verifying that all regulatory requirements are met. The competent authority should:

i. Establish regulatory systems (e.g. recall, traceback, product tracing, as appropriate, etc.) and requirements, e.g. training, knowledge, skills and ability of personnel (generally at a national level).
ii. Undertake specified meat hygiene controls that are designated activities of the competent authority, e.g., official sampling programmes, those aspects of ante and post-mortem activities specified by the competent authority, or official certification.
iii. Verify that process control systems implemented by the establishment operator meet regulatory requirements e.g. GHP, SSOPs, HACCP, as appropriate.
iv. Verify that competent bodies are carrying out functions as required.
v. Carry out enforcement actions as necessary.

The competent authority should verify compliance with:

- GHP requirements for: animals presented for slaughter (and killed wild game presented for dressing), establishments, facilities and equipment, process control, transport, and hygiene of personnel;
- SSOPs;
- HACCP plans;
- all regulatory requirements relating to ante- and post-mortem inspection;
- performance and process parameters that are regulatory requirements, e.g., microbiological statistical process control requirements, standards for *Salmonella* spp.;
- chemical residue and contaminant levels that are below maximum limits as described in relevant legislation and national sampling plans;
- official or officially-recognised zoonoses control programmes, e.g., microbiological tests for *E. coli* O157:H7; and
- additional risk management measures as specified by the competent authority.

113. Verification activities may include assessment of processing activities carried out by establishment personnel, documentary checks, organoleptic inspection of edible parts and meat, taking of samples for laboratory tests and testing for pathogens, indicator organisms, residues, etc. Approval/registration/listing of an establishment may facilitate the ability of the competent authority to verify that it is operating in compliance with regulatory requirements.

[38] Principles for the Establishment and Application of Microbiological Criteria for Foods (CAC/GL 21-1997).
[39] Bovine spongiform encephalopathy. Chapter 2.3.13. International Animal Health Code - 2000. Office International des Epizooties.

114. The competent authority should conduct appropriate supervision of (operator) verification activities, and the nature and intensity of that supervision should be risk-based. The official inspector (including the veterinary inspector) verifies compliance with the regulatory requirements and may use additional documentary checks, procedures and tests in this role. Rules governing the presence of the official inspector during ante- and post-mortem inspection, and during processing, cutting, and storage of meat, should be determined by the competent authority in relation to deployment of other competent persons, and in relation to potential risks to human health associated with the classes of animals and meat involved. The role of the competent authority(s) during distribution and retail sale of products should be of an extent that is proportional to likely generation of risks to consumers during these activities.

115. A national meat hygiene programme should be subject to verification by the competent authority.
Where the establishment operator does not comply with regulatory requirements, the competent authority should carry out enforcement actions that may include:
- slowing of production while the operator regains process control;
- stopping production, and withdrawing certification for meat deemed to be unsafe or unsuitable for its intended use;
- withdrawing official supervision, or accreditation of competent persons;
- ordering specified treatment, recall or destruction of meat as necessary; and
- withdrawing or suspending all or part of the approval/registration/listing of the establishment if process control systems are invalid or repeatedly non-compliant.

9.2.5 Quality assurance (QA) systems
116. Whenever there are verifiable QA systems in place in the industry, the competent authority should take them into account[40].

9.3 General hygiene requirements for process control

117. Process control should meet the general hygiene requirements of the Recommended International Code of Practice: General Principles of Food Hygiene[41].
General hygiene requirements for process control should include for example:
- water for cleaning and sanitising of a standard that is appropriate for the specific purpose, and used in a manner that does not directly or indirectly contaminate meat;
- cleaning of facilities and equipment that involves disassembly where necessary, removal of all debris, rinsing of parts, application of an approved cleaner, repeat rinsing, reassembly, and further sanitisation and rinsing as appropriate;
- handling and storage of containers and equipment in a way that minimises the potential for contamination of meat;
- assembly of containers or cartons in rooms or areas where meat may be present in such a manner that there is minimal possibility of contamination; and
- controlled access of personnel to processing areas.

118. The competent authority and industry should utilise appropriately accredited or otherwise recognised laboratories when verifying process control and carrying out other meat hygiene activities. Testing of samples should utilise validated analytical methods[42].

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[40] Guidelines for the Design, Operation, Assessment and Accreditation of Food Import and Export Inspection and Certification Systems - Section 4 Quality Assurance (CAC/GL 26-1997).

[41] Note that general requirements for control of incoming materials, use of water, packaging, documentation and records, and recall procedures are described in the recommended international code of practice: general principles of food hygiene (CAC/RCP 1 - 1969, Rev. 4-2003).

[42] Guidelines for the assessment of the competence of testing laboratories involved in the Import and Export Control of Food (CAC/GL 27-1997).

Laboratory testing may be required for:

- verification of process control;
- application of performance or microbiological criteria;
- residue monitoring;
- diagnosis of disease conditions affecting individual animals; and
- monitoring of zoonoses.

9.4 Hygiene requirements for slaughter and dressing

119. Only live animals intended for slaughter should be brought into an abattoir, with the exception of animals that have undergone emergency slaughter outside the slaughterhouse and have appropriate veterinary documentation.

120. No animal other than an animal intended for slaughter should enter an abattoir, with the exception of animals used for stock handling.

121. An animal should only be slaughtered or dressed in an abattoir if a competent person is available to undertake ante- and post-mortem inspection. In cases of emergency slaughter where a competent person is not available, special provisions established by the competent authority will apply to ensure that the meat is safe and suitable for human consumption.

122. All animals brought to the slaughter floor should be slaughtered without delay, and stunning, sticking and bleeding of animals should not proceed at a rate faster than that at which bodies of animals can be accepted for dressing.
During initial dressing operations, and with due consideration to minimising contamination:

- slaughtered animals that are scalded, flamed or similarly treated should be scoured of all bristles, hair, scurf, feathers, cuticles and dirt;
- the trachea and oesophagus should remain intact during bleeding, except in the case of ritual slaughter;
- bleeding should be as complete as possible; if blood is intended for food, it should be collected and handled in a hygienic manner;
- exposure of the tongue should be done in such a way that the tonsils are not cut;
- skinning of the head may not be required for some classes of animals e.g. goats, calves, sheep, provided that heads are handled in such a way as to avoid undue contamination of meat;
- before the removal from the head of any parts intended for human consumption, the head should be clean and, except in the case of scalded and dehaired carcasses, skinned to an extent sufficient to facilitate inspection and the hygienic removal of specified parts;
- lactating or obviously-diseased udders should be removed from carcasses at the earliest opportunity;
- removal of udders should be done in such as way that the contents do not contaminate the carcass;
- gas skinning or dehiding (pumping of air or gas between the skin or hide and the underlying tissue to facilitate skinning) should only be permitted if it can be achieved with minimal contamination and meets required microbiological and organoleptic performance criteria; and
- hides/fleeces should not be washed, de-fleshed or left to accumulate in any part of an abattoir or establishment that is used for slaughter or dressing.

123. Poultry and farmed game birds, following de-feathering, can only be effectively cleaned of dust, feathers and other contaminants by the application of potable water. Washing of the carcasses of these animals at multiple steps in the dressing process, and as soon as possible after each contaminating step, reduces the adherence of bacteria to the skin which can minimise overall carcass contamination. (Washing after evisceration and post-mortem is also necessary for technological reasons, as this is the only method available to routinely clean carcasses before entry

to the chilling process). Washing may be carried out by several methods e.g., spraying, immersion washing.

124. Farmed ratites may have an excessive amount of dust and dirt trapped in their feathers, and this has the potential for significant contamination of the dressing area unless there is adequate separation by distance, physical barrier, or other means, e.g., positive ventilation.

125. Once the removal of the hide/fleece has commenced, or dehairing has occurred, animal bodies should be separated from each other to avoid contact, and this should be maintained until each carcass has been examined and judged by a competent person undertaking post-mortem inspection. (Note: While full separation of carcasses is more difficult in the case of poultry and farmed game birds, such contact should be minimised).
During dressing, and with due consideration to minimising contamination:

- where bodies of animals are skinned, this process should be completed before evisceration;
- water in scalding tanks should be managed so that it is not excessively contaminated;
- evisceration should be carried out without delay;
- discharge or spillage of any material from the oesophagus, crop, stomach, intestines, cloaca or rectum, or from the gall bladder, urinary bladder, uterus or udder, should be prevented;
- intestines should not be severed from the stomach during evisceration and no other opening should be made into an intestine, unless the intestines are first effectively tied to prevent spillage, except in the case of poultry and game birds;
- stomachs and intestines and all inedible material derived from the slaughtering and/or dressing of bodies of animals should be removed as soon as possible from the dressing area, and processed in a manner that does not cause cross-contamination of meat;
- methods used to remove visible and microbial contamination should be demonstrated to be effective and meet other requirements as specified by the competent authority; and
- faecal and other material should be trimmed or otherwise removed from carcasses in a manner that does not result in further contamination, and which achieves appropriate performance criteria for process control.

126. Animal bodies and carcasses should not come into contact with surfaces or equipment unless practically unavoidable. Where use of equipment involves contact by design, e.g., in the case of automatic eviscerating machines, the hygiene of the equipment should be appropriately maintained and monitored.

127. Where a competent person undertaking post-mortem inspection considers that the manner in which animals are being slaughtered or dressed, or meat is further handled, will adversely affect the safety and suitability of meat, that competent person should enforce a reduction in the rate of production or the suspension of operations or other appropriate measures, as deemed necessary (refer to 9.2.4).

128. Establishment operators should meet the requirements of the competent authority in terms of presentation of edible parts of bodies of animals for post-mortem inspection. Parts of slaughtered animals that have been removed before post-mortem inspection is performed should remain identifiable, as belonging to a single carcass (or a group of carcasses) when required for post-mortem judgement.

129. Facilities and equipment for slaughtering and/or dressing may be used for other purposes, e.g. for animal health emergency slaughter, provided appropriate cleaning and sanitation requirements are met.

130. The competent authority should encourage development and adoption of innovative technologies and procedures at the establishment level, that reduce cross-contamination and

enhance food safety, e.g., enclosing the terminal rectal intestine in a bag and tying off.

9.5 Post-mortem inspection

131. All carcasses and other relevant parts should be subjected to post-mortem inspection, which preferably should be part of an overarching, risk-based system for the production of meat.

132. Post-mortem inspection of carcasses and other relevant parts should utilise information from primary production and ante-mortem inspection, together with the findings from organoleptic inspection of the head, carcass and viscera, to make a judgement on the safety and suitability of parts intended for human consumption. Where the results of organoleptic inspection are insufficient to accurately judge carcasses and other relevant parts as safe or suitable for human consumption, the parts should be set aside and followed up with confirmatory inspection procedures and/or tests.

9.5.1 Design of post-mortem inspection systems

133. Post-mortem inspection procedures and tests should be established by the competent authority according to a science- and risk-based approach. The competent authority has responsibility for establishing judgement criteria and verifying the post-mortem inspection system. In the absence of a risk-based system, procedures will have to be based on current scientific knowledge and practice.

134. Post-mortem procedures and tests may be integrated and implemented together so as to achieve public health and animal health objectives. In such cases, all aspects of post-mortem inspection should be science-based and be tailored to the relevant risks.

135. Relevant information on the animal population, e.g., animal type, health status, geographical region of origin, should be utilised in both the design and implementation of post-mortem inspection systems.

136. Where indicated by public health concerns, routine screening of carcasses and other relevant parts by methods other than organoleptic inspection may be required for suspected hazards, e.g., testing for Trichinella spp.

Characteristics of a risk-based post-mortem inspection programme are:

- design and application of organoleptic procedures and tests that are relevant and proportional to meat-borne risks associated with grossly-detectable abnormalities;
- tailoring of procedures to the spectrum and prevalence of diseases and defects reasonably likely to be present in the particular slaughter population, taking into account the type (age), geographical origin and primary production system of the slaughter animals, e.g., multiple incisions of relevant muscles in all pigs from geographical regions where *Taenia solium* is present;
- procedures that minimise cross-contamination through handling to the greatest extent practicable, and may include procedures that are limited to visual observation of carcasses and other relevant parts in the first instance if justified by risk assessment;
- inspection of non-edible parts of animals where they may play an indicator role in the judgement of edible parts;
- modification of traditional procedures where scientific investigation has shown them to be ineffective, or, of themselves, hazardous to food, e.g., routine incision of lymph nodes of young animals to detect granulomatous abnormalities;
- application of more intensive organoleptic procedures on a routine basis when a disease or condition capable of general distribution is found in a single part of a carcass and other relevant parts, e.g., cysts of *Taenia saginata* in cattle, xanthosis;
- application of additional risk-based inspection procedures on a routine basis when live animals are positive to a diagnostic test, e.g., tuberculin test in cattle, mallein test in horses;

- use of laboratory tests for hazards that are unaddressed by organoleptic inspection, e.g., *Trichinella* spp., chemical residues and contaminants;
- application of performance criteria for outcomes of organoleptic inspection that reflect a risk-based approach;
- integration with HACCP plans for other process control activities, e.g., establishment of zero faecal tolerance criteria for faecal contamination of carcasses;
- on-going tailoring of procedures to take into consideration information received from the primary producer on a lot-by-lot basis; and
- return of information to the primary producer so as to seek continuous improvement in the safety and suitability status of animals presented for slaughter (refer to 6.4).

9.5.2 Implementation of post-mortem inspection

137. Post-mortem inspection should occur as soon as is practicable after slaughter of animals, or delivery of killed wild game animals. Inspection should take into account all relevant information from the level of primary production and ante-mortem inspection, e.g. information from official or officially-recognised hazard control programmes, information on animals slaughtered as suspects .

138. The competent authority should determine: how post-mortem inspection is to be implemented, the training, knowledge, skills and ability required of personnel involved (including the role of the official inspector, the veterinary inspector, and any personnel not employed by the competent authority), and the frequency and intensity of verification activities (refer to 9.2.4). The final responsibility for verifying that all post-mortem inspection and judgement requirements are met should lie with the competent authority.

139. Carcasses and other relevant parts condemned by the competent person undertaking post-mortem inspection as unsafe or unsuitable for human consumption should be identified as appropriate and handled in a manner that does not result in cross-contamination of meat from other carcasses and relevant parts. The reason for condemnation should be recorded, and confirmatory laboratory tests may be taken if deemed necessary.

The responsibilities of the establishment operator in respect of post-mortem inspection include:

- maintenance of the identity of a carcass and other relevant parts (including blood as appropriate) until inspection is complete;
- skinning and dressing of heads to the extent necessary to facilitate inspection, e.g., partial skinning to allow access to sub-maxillary lymph nodes, detaching of the base of the tongue to allow access to the retropharyngeal lymph nodes;
- skinning of heads to the extent necessary to allow hygienic removal of edible parts, when this is a processing option;
- presentation of a carcass and other relevant parts for inspection according to the requirements of the competent authority;
- a prohibition on establishment personnel intentionally removing or modifying any evidence of a disease or defect, or animal identification mark, prior to post mortem inspection;
- prompt removal of foetuses from the evisceration area, for rendering or other processes as allowed by the competent authority, e.g., collection of foetal blood;
- retention in the inspection area of all carcasses and other relevant parts required for inspection, until inspection and judgement has been completed;
- provision of facilities for identifying and retaining all carcasses and other relevant parts that require more detailed inspection and/or diagnostic tests before a judgement on safety and suitability can be made, in a manner that prevents cross-contamination of meat from other carcasses and other relevant parts;
- condemnation of parts of the carcass trimmed from the region of the sticking wound;
- routine condemnation of the liver and/or kidneys from older animals where the competent authority has determined that there may be accumulation of heavy metals to an unacceptable level;

- use of health marks (as specified by the competent authority) that communicate the outcome of post-mortem inspection; and
- co-operation with competent persons undertaking post-mortem inspection, in all other ways necessary to facilitate effective post-mortem inspection, e.g., access to processing records, and easy access to all carcasses and other relevant parts.

Post-mortem inspection systems, should include:
- procedures and tests that are risk-based to the extent possible and practicable (refer to 9.5.1);
- confirmation of proper stunning and bleeding;
- availability of inspection as soon as is practicable after completion of dressing;
- visual inspection of the carcass and other relevant parts, including inedible parts, as determined by the competent authority;
- palpation and/or incision of the carcass and other relevant parts, including inedible parts, as determined by the competent authority according to a risk-based approach;
- additional palpation and/or incisions, as necessary to reach a judgement for an individual carcass and other relevant parts, and under appropriate hygiene control
- more detailed inspection of edible parts intended for human consumption compared with inspection of those parts for indicator purposes alone, as appropriate to the circumstances;
- systematic, multiple incisions of lymph nodes where incision is necessary;
- other organoleptic inspection procedures, e.g., smell, touch;
- where necessary, laboratory diagnostic and other tests carried out by the competent authority or by the establishment operator under instruction;
- performance criteria for the outcomes of organoleptic inspection;
- regulatory authority to slow or halt processing so as to allow adequate post-mortem inspection at all times;
- removal of specified parts if required by the competent authority, e.g., specified risk materials for BSE; and
- proper use and secure storage of equipment for health marking.

140. The competent authority and industry should record and disseminate the results of post-mortem inspection as appropriate. Notifiable human or animal health diseases and cases of non-complying residues or contaminants should be reported to national competent authorities as well as to the owner of the animal(s). Analysis of the results of post-mortem inspection over time is the responsibility of the competent authority, and the results of such analyses should be made available to all interested parties.

9.6 Post-mortem judgement

141. Post-mortem judgement of edible parts as safe and suitable for human consumption should primarily be based on food-borne risks to human health. Other risks to human health, e.g., from occupational exposure or from handling of meat in the home, also are an important consideration. Judgements in relation to suitability characteristics of meat should reflect consumer acceptability requirements appropriate to intended end-use[43].

142. Although outside the mandate of Codex, post-mortem inspection programmes may be utilised to identify and judge carcasses and other relevant parts according to risks to animal health, as specified in relevant national legislation.

[43] The competent authority may take into account varying needs of different consumer populations so that suitability judgements do not distort the economics of the food supply.

Judgement of edible parts as safe and suitable should take into account information from the following sources:

- information from primary production (refer to Section 6);
- observations made of animals in the lairage;
- ante-mortem inspection; and
- post-mortem inspection, including diagnostic tests, where required.

143. Judgements should be based on science and risks to human health to the greatest extent possible, with guidelines being provided by the competent authority. Judgements should only be made by competent persons. When edible parts with any abnormality are always judged to be unsafe and unsuitable for human consumption and appropriately disposed of, the level of training, knowledge, skills and ability required for judgement may be less than in situations where edible parts demonstrating an abnormality may not necessarily be removed from the food supply.

144. Where the initial results of post-mortem inspection are insufficient to accurately judge edible parts as safe or suitable for human consumption, a provisional judgement should be followed up with more detailed inspection procedures and/or tests. Pending the outcome of more detailed inspection and/or diagnostic tests, all parts of the animal that are required for further investigation should be held under the control of the competent person undertaking these activities.

Judgement categories for edible parts include:

- safe and suitable for human consumption;
- safe and suitable for human consumption, subject to application of a prescribed process, e.g., cooking, freezing[44];
- held on suspicion of being unsafe or unsuitable, pending the outcome of further procedures and/or tests.
- unsafe for human consumption i.e. due to meat-borne hazards or occupational health/meat handling hazards, but able to be used for some other purpose, e.g., pet-food, animal feedingstuffs, industrial non-food use, providing there are adequate hygiene controls to prevent any transmission of hazards, or illegal re-entry to the human food chain;
- unsafe for human consumption i.e. due to meat-borne hazards or occupational health/meat handling hazards, and requiring condemnation and destruction;
- unsuitable for human consumption, but able to be used for some other purpose, e.g., pet-food, animal feedingstuffs, industrial non-food use, providing there are adequate controls to prevent illegal re-entry to the human food chain;
- unsuitable for human consumption, and requiring condemnation and destruction; and
- unsafe for animal health reasons as specified in national legislation, and disposed of accordingly[45].

145. When edible parts are judged to be safe and suitable for human consumption subject to application of a prescribed process, the specifications for that process should be verified by the competent authority as sufficient to eliminate/reduce or adequately remove the hazard or condition of concern, e.g., specifications for retorting, high temperature rendering and freezing.

[44] The competent person can instruct that following post-mortem inspection, edible parts held under suitable inventory control can be designated as safe and suitable when subjected to a particular process e.g. freezing, cooking, canning.

[45] In some circumstances, edible parts may be judged as suitable for human consumption but subject to restricted distribution because the animals were sourced from geographical areas under quarantine for animal health reasons.

9.7 Hygiene requirements for process control after post-mortem inspection

146. Operations following post-mortem inspection include all procedures until the point of retail sales, e.g. chilling of carcasses, de-boning and cutting, further preparing, processing, packaging, freezing, storing, and distribution to the point of retail sale. Particular attention needs to paid to temperature control, with temperatures of freshly slaughtered and dressed carcasses and other edible parts being reduced as rapidly as possible to a temperature that minimises the growth of micro-organisms or the formation of toxins that could constitute a risk to human health. It is also important that the cold chain is not interrupted except to the minimal extent necessary for practical operations, e.g., handling during transportation.

147. In the case of poultry and farmed game birds, viscera or parts of viscera, apart from kidneys, should be entirely removed as soon as possible, unless otherwise permitted by the competent authority.

Meat passed as safe and suitable for human consumption should be:
- removed without delay from the dressing area;
- handled, stored and transported in a manner that will protect it from contamination and deterioration;
- held under conditions that reduce its temperature and/or water activity as quickly as possible, unless cut up or de-boned pre-rigor; and
- held at temperatures that achieve safety and suitability objectives.

In the case of poultry or farmed game birds undergoing immersion chilling:
- the immersion chilling process should meet hygiene criteria as specified by the competent authority;
- the reduction in carcass temperature should be as rapid as possible;
- carcasses emerging from the process should have a lesser microbiological count for indicator organisms and pathogens than those entering the process; and
- sanitation requirements should include complete emptying, cleaning and sanitation of tanks as appropriate.

148. An official health mark applied to meat, wrapping or packaging, should provide recognition that the product has been produced in accordance with regulatory requirements, and should assist with trace-back to the establishment of origin if required. When used as part of an official meat hygiene programme, the health mark should include the approval/registration/listing number of the establishment, be applied in such a way that it cannot be re-used, and be legible. Other marks may denote conformance with commercial specifications, or unacceptability for human consumption, e.g., distinctive brands for pet-food.

149. Official health marks may be applied directly to the product, wrapping or packaging, or be printed on a label affixed to the product, wrapping or packaging. In circumstances of bulk transport to another establishment for further handling, processing or wrapping, health marks may be applied to the external surface of the container or packaging.

Where carcasses, parts of carcasses or other meat is placed in a holding room:
- all requirements for hygienic control of operations must be adhered to e.g., chiller loading rates, stock rotation, specifications for temperature and relative humidity;
- carcasses and parts of carcasses, whether hung or placed in racks or trays, should be held in a manner permitting adequate circulation of air;
- the potential for cross-contamination via dripping of fluids should be prevented; and
- water dripping from overhead facilities and condensation should be controlled to the extent practicable, to prevent contamination of meat and food contact surfaces.

150. Rooms and equipment for cutting, mincing, mechanical separation, meat preparation and the

manufacturing of meat should be designed such that activities can be carried out separately, or in such a manner that does not led to cross contamination.

151. Fresh meat intended for cutting or de-boning should be brought into work rooms progressively as needed, and should not accumulate on work tables. If fresh meat is cut or de-boned prior to reaching temperatures that are appropriate for storage and transport, it should be immediately reduced in temperature to prescribed levels.
When fresh meat is cut or de-boned pre-rigor:
- it should be transported directly from the dressing area to the cutting up or de-boning room;
- the cutting up or de-boning room should be temperature-controlled and directly linked to the dressing areas, unless the competent authority approves alternative procedures that provide an equivalent level of hygiene; and
- cutting up, de-boning and packing should be done without delay and should meet all requirements for hygienic process control.

When raw meat is minced:
- it should be obtained only from parts of animals as approved by the competent authority e.g. striated muscle and adherent fatty tissues[46]
- it should not contain bone fragments or skin
- any grossly abnormal tissues and / or post-dressing contamination should be removed before mincing
- the competent authority may specify compositional criteria.

When raw meat is mechanically separated, the competent authority should:
- restrict the type of animal parts that can be used e.g. non-use of skulls
- set compositional standards for maximum calcium content
- require specific labelling of the final product.

When raw meat is minced, mechanically separated or used in meat preparations:
- the competent authority can specify maximum time/temperature schedules for process control at each step of production e.g. maximum times and temperatures from chilling or freezing of raw material to the time of preparation, maximum temperatures during production, maximum times before chilling or freezing
- unless used directly as an ingredient for meat preparations and manufactured meat, it should be immediately wrapped and/or packaged, followed by immediate refrigeration
- the competent authority may specify microbiological performance criteria, process criteria or microbiological criteria for raw materials and final product
- establishments should have in-line magnets or other means of detecting contamination with metal fragments as appropriate
- it should not be refrozen after thawing.

When meat preparations or manufactured meat are handled:
- the process flow of raw meat awaiting processing and during processing should ensure uniform turnover of accumulated product and avoid possible cross-contamination, e.g. between raw materials and ready-to-eat products
- supply and addition of non-meat ingredients should be subject to good hygienic practice and HACCP as appropriate and practicable, and may involve decontamination treatments e.g. for herbs and spices

[46] Striated muscles from affected animal species should have undergone an examination from Trichinella as specified by the competent authority.

- products that include non-meat protein products (as defined or standardised by Codex) should be appropriately labelled[47]
- process control for non-commercially sterile products should prevent pathogen growth and toxin production during all processing activities e.g. during fermentation, partial heat treatment, drying, maturing and curing. Process criteria may include, for example, correct pH after fermentation, correct time/temperature schedules after heating or smoking, correct moisture / protein ratio after drying, correct formulation and application of nitrite as a cure ingredient
- if heat and/or other processing treatments are not sufficient to ensure the stability of the product, the product should be cooled to an appropriate storage temperature and in a manner that ensures product safety is not compromised as a result of germination and subsequent growth of pathogenic sporeformers
- product formulations e.g. distribution of antibacterial ingredients throughout cooked sausage emulsions, addition of cultures, adjustment of pH, should achieve required levels of pathogen control
- microbiological contamination of raw meat used to produce fermented products should be as low as possible, and similarly, mechanically separated meat should only be used if appropriate time / temperature schedules to achieve product safety requirements of the competent authority are used
- processing of shelf-stable products in hermetically sealed rigid containers should be according to Codex guidelines[48]
- cooked products should achieve time / internal temperatures that are validated as achieving specified microbiological performance criteria
- pasteurisation values or other heat processes should be validated for all heat treated chilled products in hermetically sealed containers so as to ensure that product safety is maintained to the end of shelf life, taking into account all preservation factors that may be present
- unless the absence of trichinellae can be assured by testing or other means, process treatments for products containing striated muscle from affected animal species, either alone or in combination, should be sufficient to destroy trichinella
- contamination with *L. monocytogenes* of heat treated / non-shelf stable and non-heat treated / shelf stable products should be prevented by use of SSOPs and GHPs that are subject to routine microbiological verification
- dried products should be protected from environmental contamination and from reabsorption of moisture
- processes for products containing minced, comminuted or mechanically separated meat should have in-line magnets or other means of detecting contamination with metal fragments.

Where meat is packaged or wrapped:

- packaging material should be suitable for use, stored and used in a hygienic manner; and
- cases or cartons should have a suitable inner liner or other means of protecting the meat, except that the liner or other protection may not be required if pieces of meat, such as cuts, are individually wrapped before packing.

Where meat is placed in a room for freezing:

- meat that is not in cartons should be hung or placed on racks or trays in a manner that allows adequate circulation of air;
- meat that is not in cartons should be held in a manner whereby the potential for cross-contamination via dripping of liquids is prevented;
- cartons containing meat should be stacked so as to permit adequate circulation of air; and

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[47] Codex General Standard for the Labelling of Prepackaged Food (CODEX STAN 1-1985, Rev. 1-1991).

[48] Recommended International Code of Hygienic Practice for Low-Acid Canned Foods CAC/RCP 23-1979 (Rev. 1-1989).

- meat held on trays should be placed so as to avoid contact with the base of an upper tray.

Where meat is held in a freezer room or storage facility:
- the temperature of the meat should have been reduced to an acceptable level before placement;
- exposed meat must be stored in such a way that the hygiene cannot be compromised by the presence of packaged meat or packaging material;
- meat, whether in carcass form or in cartons, should not be stacked directly on the floor and should be positioned so that there is adequate air circulation;
- the freezer store should be operated and maintained under conditions appropriate to maintaining the safety and suitability of meat;
- temperatures should be continuously recorded and monitored; and
- adequate inventory control should be maintained.

152. Where raw meat is thawed for further processing, hygiene controls should be such that thawing will not result in growth of micro-organisms or the formation of toxins to the extent that they may constitute a risk to human health. Hygiene controls should include adequate drainage of liquid run-off.

153. The establishment operator should establish and implement a procedure for determining and validating the shelf life of manufactured meat and meat preparations.

154. In some circumstances RTE products that do not meet microbiological performance criteria, process criteria, or microbiological criteria, may be re-processed, condemned or treated as inedible. Where appropriate, follow-up sampling should verify that re-processed RTE products comply with regulatory microbiological requirements. When RTE products have been contaminated subsequent to cooking and/or other preservation treatment with pathogens such that they could pose a risk to public health, the products should be reworked or condemned without compromise.

155. Where establishments are approved, registered and/or listed for different animal species, all operations must be controlled in terms of space or time so that there is no possibility of accidental mixing of meat from different slaughter species, and no mis-identification at the time of packaging.

9.8 Hygiene requirements for parts of animals deemed unsafe or unsuitable for human consumption

156. Special hygiene measures should be applied to operations involving parts of animals deemed unsafe or unsuitable for human consumption. These measures should prevent cross-contamination to other edible parts and meat, and prevent any possibility of substitution.

Parts of animals deemed unsafe or unsuitable for human consumption should be:
- placed without delay into specifically identified chutes, containers, trolleys, or other handling facilities;
- identified by means as appropriate to the type and end use of the tissue;
- in the case of condemned material, handled in rooms reserved for that purpose and conveyed in a secure manner to a place of disposal (e.g. rendering station).

9.9 Recall systems

157. Establishments should have adequate systems that enable the tracing, withdrawal, and/or recall of product from the food chain. The competent authority should require verification that the systems are adequate. In the case of a recall, communication with consumers and interested parties should be considered, and undertaken where appropriate.

158. Where a recall, or seizure of meat by the competent authority is necessary, the amount of product involved may be more than that from a single production or sampled lot. In such cases the competent authority should verify to the extent practicable that the establishment has taken all steps necessary to ensure all affected product or potentially affected product is included in the recall. In the case of microbiological hazards in meat preparations and manufactured meat, the decision should be risk based and will depend on a number of factors, including the pathogen involved, the type of processing and packaging, and all the microbiological data available.

159. Recalled product may be used for purposes other than human consumption, where appropriate, or re-processed in a manner that ensures safety and suitability.
Recall systems designed by the establishment operator should:

- utilise the approval/registration/listing number of the establishment as a means to identify meat to its final destination;
- incorporate management systems and procedures that facilitate rapid and complete recall of implicated lots e.g. distribution records, lot coding;
- keep records that facilitate trace-back to the place of origin of the animals, to the extent practicable; and
- keep records that facilitate investigation of any processing inputs that may be implicated as a source of hazards.

10. ESTABLISHMENTS: MAINTENANCE AND SANITATION

160. The principles and guidelines presented in this section are supplemental to the objectives and guidelines in Section VI of the Recommended International Code of Practice: General Principles of Food Hygiene (CAC/RCP 1-1969, Rev 4-2003).

10.1 Principles of meat hygiene applying to maintenance and sanitation of establishments, facilities and equipment

i. Establishments, facilities and equipment should be maintained and sanitised in such a manner that contamination of meat is minimised to the greatest extent practicable.
ii. Documented programmes for effective and appropriate maintenance and sanitation should be in place (refer to 9.2.1).
iii. Monitoring of the effectiveness of maintenance and sanitation should be included as a basic component of meat hygiene programmes (refer to 9.2.1).
iv. Special sanitation requirements should be applied to the slaughter and dressing of animals that are condemned or designated as suspects .

10.2 Maintenance and sanitation

161. Establishments, facilities and equipment should be kept in an appropriate state of repair and condition to facilitate all sanitation procedures and prevent contamination of meat, e.g., from metal shards, flaking plaster and chemical contaminants.

162. SSOPs should specify the scope of the cleaning programme, cleaning specifications, persons responsible, and monitoring and record keeping requirements.
Cleaning procedures and programmes should:

- be specified in SSOPs as appropriate to the circumstances;
- provide for removal and storage of waste;
- ensure that there is no consequential contamination of meat with detergents or sanitising agents, unless allowable under conditions of use; and

- be monitored for their effectiveness, e.g., organoleptic checks and microbiological sampling of meat contact surfaces, and be redesigned if and when necessary.

163. Particular cleaning programmes are required for equipment used in the slaughter and dressing of carcasses e.g., knives, saws, machine cutters, evisceration machines and flushing nozzles.

Such equipment should be:

- clean and sanitised before each new period of work;
- cleaned, and sanitised, by immersion in hot water or alternative methods, with appropriate frequency during and/or between periods of work;
- immediately cleaned and sanitised when coming into contact with abnormal or diseased tissue that may harbour food-borne pathogens; and
- stored in designated areas in such a manner that it will not become contaminated.

164. Containers and equipment should not pass from an inedible area to an edible area before being cleaned and sanitised.

165. Pest control programmes are an essential part of maintenance and sanitation and should follow GHP as described in the Recommended International Code of Practice: General Principles of Food Hygiene[49].

In particular:

- the programme should be properly documented and verified by the establishment operator;
- treatment of areas, rooms, facilities and equipment, with an approved pesticide should be carried out according to the conditions of use; and
- pesticides and other pest control chemicals should be kept in secure storage, with access being limited to authorised persons.

11. PERSONAL HYGIENE

166. Slaughter and dressing of animals, and handling and inspection of meat, presents many opportunities for cross-contamination. Personal hygiene practices should prevent undue general contamination, and prevent cross-contamination with human pathogens that may cause food-borne disease. The guidelines presented in this section are supplemental to the objectives and guidelines in Section VII of the Recommended International Code of Practice: General Principles of Food Hygiene (CAC/RCP 1-1969, Rev 4-2003).

167. Persons moving from rooms or areas containing raw meat to rooms or areas used for meat preparations and manufactured meat (especially when these products are cooked) should thoroughly wash, change and/or sanitise their protective clothing as appropriate, and otherwise limit the possibility of cross-contamination to the lowest level practicable.

11.1 Personal cleanliness

168. Persons who come into direct or indirect contact with edible parts of animals or meat in the course of their work should maintain appropriate personal cleanliness and behaviour, and should not be clinically affected by communicable agents likely to be transmitted by meat.

Persons who come into direct or indirect contact with edible parts of animals or meat should:

- maintain an appropriate standard of personal cleanliness;
- wear protective clothing appropriate to the circumstances, and ensure that non-disposable protective clothing is cleaned before and during work;

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[49] Recommended International Code of Practice: General Principles of Food Hygiene (CAC/RCP 1 - 1969, Rev. 4-2003).

- if wearing gloves during the slaughter and dressing of animals and the handling of meat, ensure that they are of an approved type for the particular activity, e.g., chain-mail stainless steel, synthetic fabric, latex, and they are used according to specifications, e.g., washing of hands before use, changing or sanitising gloves when contaminated;
- immediately wash and sanitise hands and protective clothing when there has been contact with abnormal animal parts that are likely to harbour food-borne pathogens;
- cover cuts and wounds with waterproof dressings; and
- store protective clothing and personal effects in amenities that are separate from areas where meat may be present.

11.2 Personal health status

169. The establishment should maintain relevant personal health records of personnel.

Persons who come into direct or indirect contact with edible parts of animals or meat in the course of their work should:

- where necessary, have a medical examination prior to and during employment;
- not work while clinically affected by, or suspected to be carrying, communicable agents likely to be transmitted through meat; and
- be aware of and comply with reporting requirements to the establishment operator in respect of communicable agent.

12. TRANSPORTATION

170. The guidelines presented in this section are supplemental to the objectives and guidelines in Section VIII of the Recommended International Code of Practice: General Principles of Food Hygiene (CAC/RCP 1-1969, Rev 3-1997, Amended 1999).

171. Due to the potential for growth of pathogenic and spoilage micro-organisms under conditions of inadequate temperature control, meat should be transported at temperatures that achieve safety and suitability objectives. Equipment for continuous monitoring and recording of temperatures should accompany transport vehicles and bulk containers wherever appropriate. Additionally, the conditions of transport should provide adequate protection from exogenous contamination and damage, and should minimise growth of pathogenic and spoilage micro-organisms.

172. If meat is inadvertently exposed to adverse temperature conditions or sources of contamination that may affect safety and suitability, an inspection should be carried out by a competent person before further transport or distribution is allowed.

13. PRODUCT INFORMATION AND CONSUMER AWARENESS

173. Appropriate product information and adequate knowledge of food hygiene is necessary to prevent mishandling at later stages in the food chain. Pre-packaged foods should be labelled with clear instructions to enable the next person in the food chain to handle, display, store and use the product safely. Principles and guidelines for product information and consumer awareness in the context of safety and suitability of meat are described in general terms in Section IX of the Recommended International Code of Practice: General Principles of Food Hygiene (CAC/RCP 1-1969, Rev 4-2003).

174. The conditions of storage of meat preparations and manufactured meat should be clearly presented on the packaging.

175. Meat preparations and manufactured meat should, where appropriate, be specifically labelled so as to provide safe handling, refrigeration and storage instructions for consumers. Foods containing meat that have not received an adequate biocidal treatment for pathogens (e.g. containing raw meat, partially cooked meat, or products with secondary inhibitors) should be labelled with handling, refrigeration, storage, cooking and preparation statements that have been validated as sufficiently biocidal.

14. TRAINING

176. Adequate training of competent personnel is of fundamental importance in the production of meat that is safe and suitable for human consumption. The principles and guidelines presented in this section are supplemental to the objectives and guidelines in Section X of the Recommended International Code of Practice: General Principles of Food Hygiene (CAC/RCP 1-1969, Rev 4-2003).

14.1 Principles of training in meat hygiene

Persons engaged in meat hygiene activities should be trained, and/or instructed to a required level of training, knowledge, skills, and ability. Training specified or recognised by the competent authority, should be:

i. appropriate to the activities and operations;
ii. proportional to the potential of the particular meat hygiene activity to impact on food-borne risks to human health;
iii. properly documented, including records of training programme delivery;
iv. verified as appropriate; and
v. subject to recognition by the competent authority where delivered by third parties.

14.2 Training programmes

Training programmes should:

- provide personnel with the training, knowledge, skills and ability to carry out specified meat hygiene tasks, e.g., post-mortem inspection, verification of statistical process control, HACCP;
- provide practical training to the extent required;
- where necessary, arrange for formal testing of personnel;
- ensure that personnel involved in supervisory roles have appropriate skills;
- recognise and build on professional qualifications; and
- provide for the continuing education of competent persons.

In recent years, public concern about the safety of foods of animal origin has heightened due to problems that have arisen with bovine spongiform encephalopathy (BSE), as well as with outbreaks of food-borne bacterial infections, and food contamination with toxic agents (e.g. dioxin). These problems have serious implications for national food safety, the development of the animal products industry and for international trade in livestock products. The purpose of this manual on *Good practices for the meat industry* is to provide updated comprehensive information and practical guidelines for the implementation of the new *Code of hygienic practice for meat*, when adopted by the Codex Alimentarius Commission. The publication is intended to guide managers of abattoirs and the meat industry. It will also be of value to veterinarians engaged in meat inspection, with their supervisory roles in meat hygiene. The manual is published in detachable modules and also serves as a training resource.

ISBN 92-5-105146-1 ISSN 1810-1119

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TC/M/Y5454E/1/6.04/1630