Canadian Council on Animal Care

# guidelines on:

# the care and use of farm animals in research, teaching and testing

This document, the *CCAC guidelines on: the care and use of farm animals in research, teaching and testing*, has been developed by the *ad hoc* subcommittee on farm animals of the Canadian Council on Animal Care (CCAC) Guidelines Committee.


Dr. Tarjei Tennessen, Nova Scotia Agricultural College (Chair)
Dr. Laurie Connor, University of Manitoba
Dr. Anne Marie de Passillé, Agriculture and Agri-Food Canada
Dr. Ian Duncan, University of Guelph
Dr. John Feddes, University of Alberta
Dr. Marilyn Keaney, University of Ottawa
Dr. Harpreet Kochhar, Canadian Food Inspection Agency
Ms. Shelagh MacDonald, Canadian Federation of Humane Societies
Dr. Jeff Rushen, Agriculture and Agri-Food Canada
Dr. Fred Silversides, Agriculture and Agri-Food Canada
Dr. Kim Stanford, Alberta Agriculture Food and Rural Development
Dr. Marina von Keyerserlingk, University of British Columbia
Dr. Gilly Griffin, Canadian Council on Animal Care.



In addition, the CCAC is grateful to Dr. David Fraser, University of British Columbia, and Dr. Alex Livingston, University of Saskatchewan, who provided considerable assistance in preliminary phases of this project. The CCAC also thanks the many individuals, organizations and associations that provided comments on earlier drafts of this guidelines document. In particular, thanks are extended to representatives of the Canadian Society of Animal Science.





ISBN: 978-0-919087-50-7

Canadian Council on Animal Care
1510–130 Albert Street
Ottawa ON CANADA
K1P 5G4

http://www.ccac.ca

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# the care and use of farm animals in research, teaching and testing

## 1. PREFACE

The Canadian Council on Animal Care (CCAC) is responsible for overseeing the use of animals in science. The CCAC publishes guidelines on the general care and use of animals in science, as well as on issues of current and emerging ethical concern (www.ccac.ca). The *CCAC guidelines on: the care and use of farm animals in research, teaching and testing* is the eighth of this series. This document replaces Chapter IV—Farm Animal Facilities and Environment, and sections B and C of Chapter VI—Social and Behavioural Requirements of Experimental Animals in the *Guide to the Care and Use of Experimental Animals*, vol. 1, 2nd ed. (CCAC, 1993). The present document has drawn substantially from the work of the organizations listed in Appendix A.

These guidelines aim to provide information for investigators, animal care committees, facility managers and animal care staff that will assist in improving both the care given to farm animals and the manner in which experimental procedures are carried out. The refinement of animal care and use guidelines is a continuous process. These guidelines are intended primarily to provide assistance in the implementation of best practices. **Where regulatory requirements are involved or where it is an absolute imperative to adhere to a particular guideline, the term *must* has been used. The term *should* has been used to identify recommended best practices. Deviating from best practice is allowed if the experiment or other animal use requires it, but must be approved by the local animal care committee.**

These guidelines apply to farm animals used by institutions for scientific purposes. While these animals are mostly used for agricultural research and teaching purposes, some institutions use farm animals for testing purposes, in particular for disease control or vaccine development. Farm animals are also used to model or understand biological processes, and some of these studies involve the genetic modification of animals. The end goal of these studies may be related to food or fibre production, production of substances such as pharmaceuticals, or biomedical research.

This document has been organized in a format that should facilitate easy access to relevant sections. Early sections provide an ethical overview of the use of farm animals in science. This is followed by a brief overview of regulations and responsibilities relevant to the care and use of farm animals in Canada. A series of general sections then lays out the requirements that should be met irrespective of the species, followed by more detailed species-specific recommendations and recommendations for particular types of experimental studies.

**The recommendations reflect the conditions under which animals should be cared for and maintained. However, it is recognized that deviation from these recommendations may be necessary when animals are involved in particular scientific protocols. Where this occurs, these recommendations should be followed as closely as possible within the requirements of the experimental study, in order to minimize the impact on the animals.**

# SUMMARY OF THE GUIDELINES LISTED IN THIS DOCUMENT

## 2. INTRODUCTION

### Guideline 1:

Farm animals can experience pain and distress as a result of poor housing and husbandry, invasive management procedures, and experimental procedures. Investigators and those responsible for the care of animals have an obligation to mitigate or minimize potential pain and distress whenever possible, and in a manner consistent with good scientific principles.

*Subsection 2.2 Description of Animal Welfare, p. 12*

### Guideline 2:

The use of animals, including farm animals, for scientific purposes is acceptable only if it contributes to the understanding of fundamental biological, behavioural or agricultural principles, or to knowledge that can be expected to benefit humans, animals or ecosystems. Evaluation of proposals must attest to the potential value of studies involving farm animals.

*Subsection 2.4 Ethical Considerations in Care and Use of Farm Animals, p. 13*

### Guideline 3:

All projects involving the use of animals for scientific purposes must be described within a protocol, and must be approved by an animal care committee prior to commencement of the work.

*Subsection 2.4.1 Responsibilities of investigators, p. 14*

### Guideline 4:

Investigators, technical staff and students working with farm animals must receive training in animal behaviour and humane handling, and be evaluated regularly by a qualified agency / person for their competency in working with farm animals.

*Subsection 2.4.1 Responsibilities of investigators, p. 14*

### Guideline 5:

Investigators are responsible for their own conduct, as well as for the behaviour and safety of personnel working with them on a study.

*Subsection 2.4.1 Responsibilities of investigators, p. 14*

### Guideline 6:

Investigators are responsible for, and must comply with, Workplace Hazardous Materials Information System (WHMIS) and all other Occupational Health and Safety (OH&S) regulations regarding the protection of staff from known or suspected hazardous compounds, equipment and situations associated with their project.

*Subsection 2.4.1 Responsibilities of investigators, p. 14*

### Guideline 7:

Veterinary care must be provided for all animals used in science in accordance with the most recent edition of the Canadian Association of Laboratory Animal Medicine (CALAM) *Standards of Veterinary Care*.

*Subsection 2.4.4 Responsibilities of the veterinarian, p. 15*

### Guideline 8:

The animal care committee must approve all protocols to be conducted within its jurisdiction, no matter who will be conducting them (*CCAC policy statement on: animal-based projects involving two or more institutions*, 2003; *CCAC policy statement on: terms of reference for animal care committees*, 2006). The animal care committee must also review all studies that are conducted by investigators affiliated with their institution or agency, regardless of whether that project will be conducted within their jurisdiction or in the jurisdiction of another animal care committee.

*Subsection 2.4.5 Responsibilities of the ACC, p. 16*

### Guideline 9:

Local animal care committees with farm animal facilities in their jurisdiction should include persons with relevant expertise with farm animals or should have access to an advisor(s) that would provide knowledgeable input.

*Subsection 2.4.5 Responsibilities of the ACC, p. 17*

## 3. FACILITIES

**Guideline 10:**

Farm animal housing facilities should be designed to accommodate the scope and type of research, teaching and/or testing to be conducted.

*p. 19*

**Guideline 11:**

Housing should provide each animal with a safe area with adequate access to nutritious feed and fresh water; an appropriate, comfortable, bedded and well-drained lying area; suitable surfaces for walking; shelter from adverse weather; and sufficient space to interact socially (including space for subordinates to escape from dominant animals).

*Subsection 3.2.2 Basic components of a farm animal facility, p. 20*

**Guideline 12:**

Flooring should provide a dry, comfortable lying surface; it should allow animals to go through their normal movements and postural changes without slipping, and it should not result in injuries.

*Subsection 3.2.7 Floors, p. 22*

**Guideline 13:**

All provincial and local laws and regulations with respect to manure handling must be followed.

*Subsection 3.2.8 Manure handling, p. 22*

**Guideline 14:**

The environmental control system should provide an acceptable thermal (temperature and airspeed) and non-thermal (air quality) environment throughout the animal's life.

*Subsection 3.3.2 Ventilation, p. 23*

**Guideline 15:**

All facilities must have sufficient capacity to handle emergencies, including the capability to maintain acceptable air quality, temperature and water supply.

*Subsection 3.5 Emergency Preparedness (Prevention and Action), p. 25*

**Guideline 16:**

A proper alarm system and associated Standard Operating Procedures addressing emergency circumstances must be in place. Checklists should be established to ensure that testing, preventive maintenance and servicing occur at frequent and regular intervals.

*Subsection 3.5 Emergency Preparedness (Prevention and Action), p. 25*

## 4. FACILITY MANAGEMENT

**Guideline 17:**

Facilities must be maintained to a high standard. Standard Operating Procedures should be developed specifically for the facility, describing cleaning and disinfection of facilities and equipment, including animal housing pens.

*Subsection 4.1 Maintenance, p. 28*

**Guideline 18:**

Facility staff require specialized knowledge, experience and training for proper function, operation and maintenance of the facility.

*Subsection 4.1 Maintenance, p. 28*

**Guideline 19:**

Programs for vermin control should be in place to deal with invertebrate and vertebrate pests. Safe, humane and environmentally sound methods of pest control should be used.

*Subsection 4.2 Feed, Water and Bedding, p. 28*

## 5. ACQUISITION, TRANSPORTATION AND QUARANTINE

**Guideline 20:**

Animals should be obtained from reputable sources with good health management, and animals should have known health status.

*Subsection 5.1 Acquisition, p. 32*

**Guideline 21:**

After transportation, and before use in any experiments, animals should be acclimatized to the experimental conditions.

*Subsection 5.2.1 Acclimation, p. 32*

**Guideline 22:**

The goal of quarantine is to monitor and ensure the health of the animals, and thereby protect the health of conspecifics already resident at the facility.

*Subsection 5.3 Quarantine, p. 33*

**Guideline 23:**

Extra vigilance should be paid to monitoring the animals and to maintaining good records, in order to detect and respond to any health problems in quarantined animals.

*Subsection 5.3 Quarantine, p. 33*

**Guideline 24:**

Quarantine areas should be managed according to rigorous infectious agent control practices.

*Subsection 5.3 Quarantine, p. 33*

## 6. HUSBANDRY

**Guideline 25:**

Each facility should have Standard Operating Procedures for routine husbandry and routine invasive practices.

*Subsection 6.1 Standard Operating Procedures (SOPs), p. 34*

**Guideline 26:**

Electro-immobilization must not be used.

*Subsection 6.7 Restraint, p. 36*

**Guideline 27:**

Routine invasive agricultural practices that are likely to cause pain must be described in Standard Operating Procedures that are reviewed and approved by an animal care committee.

*Subsection 6.8 Routine Invasive Agricultural Practices, p. 36*

**Guideline 28:**

All facilities must have a herd /flock health program.

*Subsection 6.10.1 Herd/flock health program, p. 37*

**Guideline 29:**

Strategic measures for disease prevention should include 1) formal written agreement with a veterinarian responsible for the management of the health program; 2) a program for disease control measures, including quarantine, immunization and prophylactic treatments; and 3) a system of regular monitoring and reporting for health assessment purposes.

*Subsection 6.10.1 Herd/flock health program, p. 37*

**Guideline 30:**

Standard Operating Procedures should be developed for health care and to address common problems for the herd / flock.

*Subsection 6.10.1 Herd/flock health program, p. 38*

**Guideline 31:**

All staff must be appropriately trained and competent with the husbandry skills required to ensure the health and welfare of animals in their care.

*Subsection 6.12 Staff and Training, p. 40*

## 8. TEACHING

**Guideline 32:**

Untrained students must be instructed by a trained instructor who must supervise all aspects of their performance until they are deemed competent.

*Subsection 8.1 Supervision, p. 43*

**Guideline 33:**

When planning student exercises with animals, the instructor must carefully weigh the pedagogical merit of the procedure against the invasiveness of the procedure and how often it will be carried out on each animal.

*Subsection 8.2 Frequency-of-Use, p. 43*

## 9. SPECIALIZED PROCEDURES USED IN RESEARCH AND TESTING

**Guideline 34:**

Metabolism crates must only be used for approved short-term studies, not for routine housing.

*Subsection 9.2 Metabolism Studies, p. 45*

**Guideline 35:**

Metabolism crates must have enough room for animals to adopt comfortable resting positions, and must be well maintained to prevent injury.

*Subsection 9.2 Metabolism Studies, p. 45*

**Guideline 36:**

Animals should not be held in metabolism crates for longer than seven days without at least a 24 hour period of turn out (opportunity for exercise), and no more than two months in total.

*Subsection 9.2 Metabolism Studies, p. 46*

**Guideline 37:**

Surgical procedures must only be performed by well-trained, competent individuals.

*Subsection 9.4 Surgical Procedures, p. 48*

**Guideline 38:**

The earliest endpoint that is compatible with the scientific objectives of the approved protocol should be used.

*Subsection 9.6 Endpoints, p. 49*

**Guideline 39**

The duration of the study should be considered in relation to the growth and life stage of the animal.

*Subsection 9.7.2 Selection of appropriate animal model, p. 50*

**Guideline 40:**

Careful consideration should be given to experimental design, in particular to address the genetic variability of farm animal species.

*Subsection 9.7.2 Selection of appropriate animal model, p. 50*

**Guideline 41:**

The experimental design should address the behavioural needs of the research animals and ensure that these can be normally and safely expressed.

*Subsection 9.7.4 Meeting the social and behavioural needs of the animals in a confined environment, p. 51*

**Guideline 42:**

Farm animals that prefer to live in flocks or herds should be housed in groups, where possible. If singly housed, they should be in a room with other socially compatible animals.

*Subsection 9.7.4 Meeting the social and behavioural needs of the animals in a confined environment, p. 51*

**Guideline 43:**

When housing constraints are imposed, their effects should be taken into account in interpreting animal behaviour and experimental data.

*Subsection 9.7.4 Meeting the social and behavioural needs of the animals in a confined environment, p. 51*

**Guideline 44:**

Animals subjected to close confinement should be provided with the opportunity for regular exercise at least every 7 days.

*Subsection 9.7.4 Meeting the social and behavioural needs of the animals in a confined environment, p. 51*

**Guideline 45:**

Where there is a requirement for sustained human-animal interaction, animals should be habituated to handling.

*Subsection 9.7.4 Meeting the social and behavioural needs of the animals in a confined environment, p. 52*

**Guideline 46:**

In vivo medical devices research must take into account the effect of the device, device deployment systems, device-patient interfaces and performance instrumentation in relation to animal well-being.

*Subsection 9.7.6 Medical devices research, p. 52*

**Guideline 47:**

The implications of device failure must be considered in relation to the animal and the operators.

*Subsection 9.7.6 Medical devices research, p. 52*

**Guideline 48:**

Genetically-engineered animals should be given at least two separate types of identification.

*Subsection 9.8.4 Tracking, p. 55*

**Guideline 49:**

Genetically-engineered animals should be confined within at least two physical barriers at all times.

*Subsection 9.8.5 Confinement, p. 55*

**Guideline 50:**

Access to facilities confining genetically-engineered animals should be restricted to authorized personnel.

*Subsection 9.8.5 Confinement, p. 55*

**Guideline 51:**

Biosecure transit must be in place for transfers of all genetically-engineered animals to preclude their accidental release.

*Subsection 9.8.6 Transportation, p. 55*

## 10. SPECIES-SPECIFIC CONSIDERATIONS

### 10.1 Dairy Cattle

**Guideline 52:**

Regardless of the type of housing used for dairy cattle, there must be a dry, comfortable lying area for every animal.

*Subsection 10.1.1 Facilities and facility management, p. 57*

**Guideline 53:**

Group penning facilities and feeder design should be of appropriate scale for the breed and size of cattle housed.

*Subsection 10.1.1 Facilities and facility management, p. 57*

**Guideline 54:**

Where dairy cattle are housed with free stalls, there should be at least one stall for each cow within the group.

*Subsection 10.1.1 Facilities and facility management, p. 57*

**Guideline 55:**

Most flooring inside cattle barns should be compressible, provide good traction, and be well drained.

*Subsection 10.1.1 Facilities and facility management, p. 59*

**Guideline 56:**

Dairy calves should not be transported or brought into the facility unless they are healthy, have been fed colostrum, and have a dry umbilicus. Calves should be at least one week of age.

*Subsection 10.1.2 Acquisition, transport and quarantine, p. 60*

**Guideline 57:**

Dairy calves should not be purchased from sources that do not provide them with sufficient colostrum.

*Subsection 10.1.2 Acquisition, transport and quarantine, p. 60*

**Guideline 58:**

Wherever possible, diary cattle should have access to pasture in the summer months.

*Subsection 10.1.3.1 Housing and animal management, p. 61*

**Guideline 59:**

Dairy cows kept in tie-stalls should be allowed a period of exercise every day.

*Subsection 10.1.3.1 Housing and animal management, p. 61*

**Guideline 60:**

Where possible, dairy calves should be housed in groups with appropriate management.

*Subsection 10.1.3.1 Housing and animal management, p. 61*

**Guideline 61:**

A Standard Operating Procedure for colostral management and feeding to dairy calves should include regular testing of colostrum quality, as well as calf serum immunoglobulin levels.

*Subsection 10.1.3.2 Feed and water, p. 62*

**Guideline 62:**

Milk-fed dairy calves should be fed a quantity of milk equivalent to at least 20% of their body weight per day.

*Subsection 10.1.3.2 Feed and water, p. 62*

**Guideline 63:**

Dairy cattle should have adequate bedding.

*Subsection 10.1.3.3 Bedding, p. 62*

**Guideline 64:**

Milk-fed dairy calves should be fed milk through teats.

*Subsection 10.1.3.4 Environmental improvement, p. 63*

**Guideline 65:**

Employees responsible for handling cattle should receive instruction in low-stress methods of handling.

*Subsection 10.1.3.5 Human contact and handling, p. 63*

**Guideline 66:**

The electric prod must not be used in routine handling.

*Subsection 10.1.3.5 Human contact and handling, p. 63*

**Guideline 67:**

Anesthetics and analgesics should be used for castrating cattle.

*Subsection 10.1.3.8 Routine invasive agricultural practices, p. 64*

**Guideline 68:**

Adult cattle should not undergo dehorning procedures.

*Subsection 10.1.3.8 Routine invasive agricultural practices, p. 64*

**Guideline 69:**

Disbudding and dehorning are painful and stressful procedures, and effective pain control methods must be used.

*Subsection 10.1.3.8 Routine invasive agricultural practices, p. 64*

**Guideline 70:**

Cattle should not be branded. Where branding is essential or required by law for identification, then only one brand should be used.

*Subsection 10.1.3.8 Routine invasive agricultural practices, p. 65*

**Guideline 71:**

Dairy cattle must not be tail docked.

*Subsection 10.1.3.8 Routine invasive agricultural practices, p. 65*

**Guideline 72:**

A program of preventive health care should be established in consultation with a veterinarian.

*Subsection 10.1.3.10 Health and disease control, p. 65*

**Guideline 73:**

Incidence of mortality among unweaned dairy calves should be recorded, and should be kept below 2%, excluding cases of stillborns.

*Subsection 10.1.3.10 Health and disease control, p. 66*

**Guideline 74:**

Incidence of dairy cows that develop mastitis during a lactation should be kept as low as possible, and below 15%.

*Subsection 10.1.3.10 Health and disease control, p. 66*

**Guideline 75:**

Records of the incidence of lameness and hoof lesions should be maintained. The incidence of lameness among lactating dairy cows should be kept below 10% per lactation.

*Subsection 10.1.3.10 Health and disease control, p. 66*

**Guideline 76:**

Cattle should not be fed diets that lead to acidosis.

*Subsection 10.1.3.10 Health and disease control, p. 67*

**Guideline 77:**

Non-ambulatory cattle must not be transported, except in certain exceptional circumstances such as for veterinary treatment.

*Subsection 10.1.3.11 Disposal of animals, p. 67*

### 10.2 Beef Cattle

**Guideline 78:**

Group penning facilities and feeder design should be of appropriate scale for the breed and size of cattle housed.

*Subsection 10.2.1 Facilities and facility management, p. 69*

**Guideline 79:**

Most flooring inside cattle barns should be compressible, provide good traction and be well drained.

*Subsection 10.2.1 Facilities and facility management, p. 70*

**Guideline 80:**

Where possible, only preconditioned beef cattle should be purchased.

*Subsection 10.2.2 Acquisition, transport and quarantine, p. 71*

**Guideline 81:**

Where possible, polled beef cattle should be used.

*Subsection 10.2.2 Acquisition, transport and quarantine, p. 71*

**Guideline 82:**

Employees responsible for handling cattle should receive instruction in low-stress methods of handling.

*Subsection 10.2.3.5 Human contact and handling, p. 72*

**Guideline 83:**

The electric prod must not be used in routine handling.

*Subsection 10.2.3.5 Human contact and handling, p. 73*

**Guideline 84:**

Anesthetics and analgesics should be used for castrating cattle.

*Subsection 10.2.3.8 Routine invasive agricultural practices, p. 73*

**Guideline 85:**

Adult cattle should not undergo dehorning procedures.

*Subsection 10.2.3.8 Routine invasive agricultural practices, p. 74*

**Guideline 86:**

Disbudding and dehorning are painful and stressful procedures, and effective pain control methods must be used.

*Subsection 10.2.3.8 Routine invasive agricultural practices, p. 74*

**Guideline 87:**

Cattle should not be branded. Where branding is essential or required by law for identification, then only one brand should be used.

*Subsection 10.2.3.8 Routine invasive agricultural practices, p. 74*

**Guideline 88:**

A program of preventive health care should be established in consultation with a veterinarian.

*Subsection 10.2.3.10 Health and disease control, p. 75*

**Guideline 89:**

Cattle should not be fed diets that lead to acidosis.

*Subsection 10.2.3.10 Health and disease control, p. 76*

**Guideline 90:**

Non-ambulatory cattle must not be transported, except in certain exceptional circumstances such as for veterinary treatment.

*Subsection 10.2.3.11 Disposal of animals, p. 76*

### 10.3 Sheep and Goats

**Guideline 91:**

Flooring inside sheep and goat barns should provide good traction and be well drained. Wherever possible, sheep and goats should be housed on compressible floors.

*Subsection 10.3.1 Facilities and facility management, p. 77*

**Guideline 92:**

Adequate ventilation must be provided for housed sheep and goats, as they are both susceptible to respiratory infections if air quality is poor.

*Subsection 10.3.1 Facilities and facility management, p. 78*

**Guideline 93:**

Sheep must not be housed in isolation. Sheep and goats should be housed with other members of their species (first choice) or in sight of other sheep or goats (second choice); however, sheep and goats should not be housed together.

*Subsection 10.3.3.1 Housing and animal management, p. 78*

**Guideline 94:**

When possible, sheep and goats should have access to the outdoors and to pasture/grazing opportunities.

*Subsection 10.3.3.1 Housing and animal management, p. 79*

**Guideline 95:**

Sheep (with the exception of hair breeds) should be sheared on an annual basis. Angora goats should be sheared every 6 months.

*Subsection 10.3.3.7 Routine husbandry practices, p. 80*

**Guideline 96:**

Tail docking should only be performed when absolutely necessary.

*Subsection 10.3.3.8 Routine invasive agricultural practices, p. 81*

**Guideline 97:**

If performed, disbudding of kids must be done with adequate analgesia, and as soon as the horn buds are palpable, provided the kid is at least 2 days of age.

*Subsection 10.3.3.8 Routine invasive agricultural practices, p. 82*

**Guideline 98:**

Lambs and kids must not be castrated unless the research project requires it.

*Subsection 10.3.3.8 Routine invasive agricultural practices, p. 82*

**Guideline 99:**

Local anesthetic and analgesic must be used for castration.

*Subsection 10.3.3.8 Routine invasive agricultural practices, p. 82*

**Guideline 100:**

Non-ambulatory sheep or goats must not be transported, except in certain exceptional circumstances, such as for veterinary treatment.

*Subsection 10.3.3.10 Disposal of animals, p. 84*

### 10.4 Pigs

**Guideline 101:**

Pig facilities should provide adequate ventilation; thermal comfort; adequate space allowance for separate dunging, feeding and resting areas; age appropriate social/group interactions; environmental improvement; adequate feed; good quality water; and measures to protect pigs from diseases.

*Subsection 10.4.1 Facilities and facility management, p. 85*

**Guideline 102:**

Tether systems for confining sows or boars must not be used.

*Subsection 10.4.1 Facilities and facility management, p. 86*

**Guideline 103:**

Pig facilities should be adequately ventilated to protect the health and welfare of both the pigs and the staff.

*Subsection 10.4.1 Facilities and facility management, p. 88*

**Guideline 104:**

Lighting of sufficient intensity to properly inspect the pigs should be provided for at least eight hours per day.

*Subsection 10.4.1 Facilities and facility management, p. 88*

**Guideline 105:**

Flooring should provide a dry, comfortable lying surface; it should allow animals to conduct their normal movements and postural changes without slipping; and it should not result in injuries.

*Subsection 10.4.1 Facilities and facility management, p. 88*

**Guideline 106:**

Facilities should be designed so that sows can be housed in groups, with sufficient space allowance and environmental complexity to minimize agonistic or aberrant behaviour.

*Subsection 10.4.1 Facilities and facility management, p. 90*

**Guideline 107:**

Pigs are social animals and should be housed in age and size appropriate groups as much as possible.

*Subsection 10.4.3.1 Housing and animal management, p. 93*

**Guideline 108:**

Sows should not be confined to gestation stalls for periods longer than 4 weeks (such as to allow time for embryos to complete implantation).

*Subsection 10.4.3.1 Housing and animal management, p. 93*

**Guideline 109:**

Boars should not be housed in sow gestation stalls.

*Subsection 10.4.3.1 Housing and animal management, p. 96*

**Guideline 110:**

Piglets should be weaned at no less than 3 weeks of age.

*Subsection 10.4.3.2 Feed and water, p. 97*

**Guideline 111:**

Group-housed sows should be individually fed.

*Subsection 10.4.3.2 Feed and water, p. 98*

**Guideline 112:**

Research and teaching facilities should provide as much environmental improvement and complexity to the pigs' environment as possible.

*Subsection 10.4.3.4 Environmental improvement, p. 99*

**Guideline 113:**

Employees responsible for handling pigs should receive instruction in low-stress methods of handling. The electric prod must not be used in routine handling.

*Subsection 10.4.3.5 Human contact and handling, p. 100*

**Guideline 114:**

Teeth clipping should be avoided as far as possible, and should be used only in case of serious problems of damage to the udder or piglets' skin.

*Subsection 10.4.3.7 Routine invasive agricultural practices, p. 101*

**Guideline 115:**

Castration of piglets should be avoided wherever possible.

*Subsection 10.4.3.7 Routine invasive agricultural practices, p. 102*

**Guideline 116:**

Analgesics should be used for castration, and anesthetics should be used whenever possible.

*Subsection 10.4.3.7 Routine invasive agricultural practices, p. 102*

**Guideline 117:**

Tail-docking should be an exceptional procedure used only in case of serious problems.

*Subsection 10.4.3.7 Routine invasive agricultural practices, p. 102*

**Guideline 118:**

Pigs should be inspected twice daily for signs of disease, injury or failure to thrive. Animals with such problems should receive prompt attention.

*Subsection 10.4.3.8 Herd health and disease control, p. 103*

**Guideline 119:**

Non-ambulatory pigs must not be loaded for transport, except in certain exceptional circumstances such as for veterinary treatment.

*Subsection 10.4.3.9 Disposal of animals, p. 104*

### 10.5 Poultry

**Guideline 120:**

Poultry housing should provide each animal with good ventilation, thermal comfort, sufficient space allowance, appropriate social/group interactions, good feed, good quality water, measures to protect the birds from diseases, and environments that are sufficiently complexity to permit the expression of highly motivated behaviours.

*Subsection 10.5.1 Facilities and facility management, p. 105*

**Guideline 121:**

As social creatures, all poultry should be housed with other members of their species where possible, or in sight of conspecifics for experiments that require individual housing.

*Subsection 10.5.2.1 Housing and animal management, p. 107*

**Guideline 122:**

Feed intake and weight gain of broiler breeders should be carefully monitored and adjusted as necessary.

*Subsection 10.5.2.2 Feed and water, p. 109*

**Guideline 123:**

Hens must not be subjected to forced moulting procedures that deprive the birds of feed or water.

*Subsection 10.5.2.2 Feed and water, p. 109*

**Guideline 124:**

Research institutions should attempt to house adult birds in floor pens or furnished cages.

*Subsection 10.5.2.3 Environmental improvement, p. 110*

**Guideline 125:**

When used for research, broilers should not be carried by one leg, and must be carefully placed in crates when loaded.

*Subsection 10.5.2.6 Human contact and handling, p. 110*

**Guideline 126:**

Strains of chickens with a low tendency for feather-pecking and cannibalism should be selected where possible, to avoid the need for beak trimming.

*Subsection 10.5.2.8 Routine invasive agricultural practices, p. 111*

**Guideline 127:**

Where beak trimming is required, the procedure should be performed when the chicks are less than 14 days old.

*Subsection 10.5.2.8 Routine invasive agricultural practices, p. 111*

**Guideline 128:**

Chickens should not be de-toed, but if the procedure must be done, it must not be carried out after one day of age.

*Subsection 10.5.2.8 Routine invasive agricultural practices, p. 111*

**Guideline 129:**

Combs of roosters should not be removed, but if they must be removed, the procedure must be carried out no later than one day of age.

*Subsection 10.5.2.8 Routine invasive agricultural practices, p. 111*

**Guideline 130:**

Whenever possible, end-of-lay hens should be euthanized on site rather than transported.

*Subsection 10.5.2.10 Disposal of animals, p. 112*

**Guideline 131:**

Euthanasia must result in rapid and reliable loss of consciousness and death, with a minimum of handling.

*Subsection 10.5.2.10 Disposal of animals, p. 112*

# 2. INTRODUCTION

## 2.1 Definition of Farm Animal

For the purposes of this document, the term farm animal refers to a mammal or bird commonly kept for agricultural purposes, including for food, fibre, fertilizer or work. The use of fish to support the aquaculture industry is covered by the *CCAC guidelines on: the care and use of fish in research, teaching and testing* (CCAC, 2005). This guidelines document provides species-specific information on cattle, sheep, pigs and poultry; however, the general principles also apply to other types of farm animals, including farmed wildlife.

## 2.2 Description of Animal Welfare

*Animal welfare* is not a term that can be given a precise scientific definition (Duncan & Dawkins, 1983; Fraser, 1995), but arose in society to express ethical concerns about the treatment of animals (Duncan & Fraser, 1998). It is a term that is used to describe the quality of life that an animal is experiencing, and is largely dependent upon the satisfaction of an individual animal's own physical, psychological and social needs. Various authors have attempted to provide definitions of animal welfare (e.g., Broom, 1986; Hurnik, 1988; , 1993). The Five Freedoms developed by the Farm Animal Welfare Council of the UK (Appendix B) provide a useful practical guide in determining whether a particular housing environment or care practice meets an animal's needs. Welfare is reduced when animals experience states of suffering such as pain, hunger, thirst, fear and frustration. It is also possible that animals may suffer from other states not experienced by human beings (Duncan, 2004). Good welfare may also involve the animal experiencing pleasurable states (Fraser & Duncan, 1998).

**<u>Guideline 1:</u>**

**Farm animals can experience pain and distress as a result of poor housing and husbandry, invasive management procedures, and experimental procedures. Investigators and those responsible for the care of animals have an obligation to mitigate or minimize potential pain and distress whenever possible, and in a manner consistent with good scientific principles.**

## 2.3 Rationale for Farm Animal Guidelines

Considerable research has documented the impact of housing and management on the welfare of most species of farm animals, and a variety of science-based standards for the care of farm animals is available. However, further improvements to animal welfare are still needed. Institutions keeping farm animals for research or teaching purposes should have current knowledge of research on farm animal welfare, and use this information when planning housing facilities and management systems. Institutions should also be aware that further research is needed to better understand farm animal behaviour and to design husbandry systems which minimize the negative effects of confinement.

In general, recommendations made in this document are aimed at providing a higher standard of animal welfare than would be achieved through implementation of the national industry recommended codes of practice for the care and handling of farm animals (available through the National Farm Animal Care Council, http://www.nfacc.ca/code.aspx). CCAC guidelines should be implemented by institutions that maintain farm animals for scientific purposes. Research and teaching institutions are considered to be in a position to provide a leadership role in the exploration and implementation of best practices for the agricultural industry. For institutions involved in teaching, it is important that both the facilities and procedures used meet the highest standards, so that students graduate fully aware of the current best practices which can be used by the agricultural industry. Research studies and testing studies are also expected to be carried out in facilities, and according to procedures, that are recognized as best practices. Where the institutional environment (including management practices) must be of direct relevance to the commercial animal production environment so that the results can be translated to the agricultural industry, the best industry standards should be used, as approved by the animal care committee (ACC). The CCAC views adherence to the national industry recommended codes of practice as minimum acceptable standards, for example for research studies conducted on commercial farms.

For farm animals used for testing purposes (e.g., for disease control or vaccine development, or blood products/materials for the diagnosis of disease), where the animals are subject to pain and/or distress as part of the protocol, these guidelines should ensure that housing and husbandry for these compromised animals do not impose an additional level of distress. These guidelines attempt to address this issue by considering the extent to which the social and behavioural needs of the animals can be met in various situations.

## 2.4 Ethical Considerations in Care and Use of Farm Animals

**Guideline 2:**

**The use of animals, including farm animals, for scientific purposes is acceptable only if it contributes to the understanding of fundamental biological, behavioural or agricultural principles, or to knowledge that can be expected to benefit humans, animals or ecosystems. Evaluation of proposals must attest to the potential value of studies involving farm animals.**

The use of animals, including farm animals, in science is only acceptable if other methods that do not involve the use of animals are deemed to be insufficient in generating the required data, information or product.

All studies, whether they are for agricultural or biomedical purposes, must undergo an independent evaluation for scientific merit or pedagogical merit, prior to ethical review by an ACC. Where this has not been carried out as part of the application for research funding, the institution must arrange for an independent review of scientific merit for research protocols or pedagogical merit for teaching protocols (see *CCAC guidelines on: animal use protocol review*, 1997; *CCAC policy statement on: terms of reference for animal care committees*, 2006).

The use of farm animals for biomedical research must be based on the appropriateness of the model for the scientific goal of the study, and not on other characteristics such as the availability of animals within the institution.

When farm animals are to be used for testing purposes, there must be assurance that the testing will be carried out according to the most current regulatory requirements, and that the planned animal use does not exceed the requirements of the regulatory authorities (CCAC, 2006).

The *CCAC policy statement on: ethics of animal investigation* (1989) applies equally to farm animals used in science as it does to laboratory animals. The underlying ethical basis of CCAC guidelines and policies requires adherence to the three principles of humane experimental technique outlined by Russell and Burch (1959): Replacement, Refinement and Reduction.

Animals may only be used if the investigator's best efforts to find a replacement to obtain the required information have failed. Investigators should ensure that they are aware of the best practices in the use of alternative models to animal use in science, and should detail the efforts that have been made to find replacement alternatives.

Reduction of animal use may not be appropriate in agricultural trials where treatment of the animal is at the herd level and is non-invasive, and in particular, where the animals may benefit from the treatment. Where the impact of the study is uncertain, the fewest animals appropriate to provide valid information and statistical significance should be used.

Numbers of animals and species maintained should not exceed the number that an institution can successfully house and care for, as outlined in these guidelines. In addition to consideration of the benefit to be gained from a project, the CCAC requires that the impact of the study on the animals be taken into consideration, as well as the conditions under which the animals are housed and cared for, i.e. the welfare of the animals.

The most humane, least invasive techniques must be used. Minimization of pain and distress must be a priority. The animal's physical and psychological well-being should always take precedence over considerations of cost and convenience. Refinement measures should aim to use techniques that have the least potential to impede normal behaviours. Investigators should use opportunities to publish refinement techniques to improve the welfare outcomes for study animals.

### 2.4.1 Responsibilities of investigators

**Guideline 3:**

**All projects involving the use of animals for scientific purposes must be described within a protocol, and must be approved by an animal care committee prior to commencement of the work.**

Investigators should work closely with the institutional veterinarians, animal scientists with relevant experience, and the ACC to complete the protocol form and to refine the proposed animal care and use practices (see *CCAC guidelines on: animal use protocol review*, 1997; *CCAC policy statement on: the importance of independent peer review of the scientific merit of animal-based research projects*, 2000; *CCAC policy statement on: terms of reference for animal care committees*, 2006).

Consultation and/or participation of a veterinarian should be sought in projects involving medical, surgical or other invasive procedures; for potential disease concerns; and for the implementation of herd health management and individual animal care as needed (CALAM, 2007).

Where studies will be conducted outside the jurisdiction of the home institution, investigators are responsible for ensuring that both their home ACC and any host institution's ACC(s) are aware of their study (*CCAC policy statement on: animal-based projects involving two or more institutions*, 2003a). Investigators are also responsible for complying with both institutions' requirements for field studies.

Procedures for identifying, recording and reporting animals involved in an investigator's study and their environment should be developed in conjunction with the appropriate stock personnel.

**Guideline 4:**

**Investigators, technical staff and students working with farm animals must receive training in animal behaviour and humane handling, and be evaluated regularly by a qualified agency/person for their competency in working with farm animals.**

**Guideline 5:**

**Investigators are responsible for their own conduct, as well as for the behaviour and safety of personnel working with them on a study.**

According to the *CCAC guidelines on: institutional animal user training* (CCAC, 1999a), investigators, graduate students and research technicians should receive training equivalent to the Core Components of the *Recommended Syllabus for an Institutional Animal User Training Program* (CCAC, 1999b), and should have completed additional training to meet the Syllabus requirements on the use of farm animals in research, teaching and testing, including hands-on training and supervision as appropriate. Undergraduate students and other students working on research projects who have not yet received training according to CCAC guidelines must be adequately supervised.

**Guideline 6:**

**Investigators are responsible for, and must comply with, Workplace Hazardous Materials Information System (WHMIS) and all other Occupational Health and Safety (OH&S) regulations regarding the protection of staff from known or suspected hazardous compounds, equipment and situations associated with their project.**

### 2.4.2 Responsibilities of the institution

A senior institutional official must be identified in the Terms of Reference of the institution's ACC as having overall responsibility for the institution's animal care and use program. This person must ensure that appropriate animal care and use services are provided to meet the institution's scientific goals, and that all animal care and use is conducted appropriately, according to institutional and CCAC policies and guidelines (*CCAC policy statement for: senior administrators responsible for animal care and use programs*, 2008).

The institution plays a key role in working with the facility manager and institutional veterinarian to set up the animal health program (including both prevention and intervention), with good reporting and communication procedures in place for all involved in the care of the animals. It is also the institution's responsibility to ensure that a biosecurity plan is in place (see Section 4.6 Security, Access, Biosecurity and Risk Management).

The institution is responsible for ensuring that staff are appropriately trained for the facility maintenance and animal care tasks required by their position, and are aware of the associated risks and how to minimize them.

One of the most important factors in the provision of appropriate animal care for farm animals is the attitude and concern for animal well-being by the animal attendants and herdspeople. Providing periodic educational workshops or other training opportunities on animal welfare, handling, animal behaviour and animal needs is necessary to keep the workers highly skilled and motivated. Animal workers should be familiar with the behaviour of normal animals, as well as animals experiencing stress or compromised welfare, in order to improve animal comfort effectively when required. On-the-job training with adequate supervision is a valuable means for personnel to acquire good animal care skills.

Facility managers should also be provided with relevant continuing education to assist them in ensuring that their facilities are managed according to best practices.

### 2.4.3 Responsibilities of the facility manager

Irrespective of the size of the facility, a facility manager (or farm manager) should be designated as responsible for the day-to-day management of the facilities; the reception, transfer and housing of animals; the maintenance of the infrastructure; the daily care of the animals; and good communication with the veterinarian to ensure the health and welfare of the animals. The facility manager should report to a senior administrative official responsible for providing appropriate, well-equipped facilities and competent veterinary and animal care services. The facility manager should also report to the senior administrative official who is ultimately responsible (through the ACC) for ensuring compliance with all relevant guidelines, policies, procedures and regulations (CCAC, 2008).

The facility manager must work closely with the veterinarian(s), the ACC and institutional administrators to ensure appropriate veterinary services for the animals. The facility manager must ensure a herd/flock health program is in place (see Section 6.10.1 Herd/flock health program) and that measures are taken to treat common problems such as lameness in cattle and diseases. Irrespective of the size or complexity of an institutional animal care program, the services of a veterinarian must be available at all times.

### 2.4.4 Responsibilities of the veterinarian

<u>**Guideline 7:**</u>

**Veterinary care must be provided for all animals used in science in accordance with the most recent edition of the Canadian Association for Laboratory Animal Medicine (CALAM) *Standards of Veterinary Care*.**

All veterinarians providing services to Canadian scientific institutions must work according to the most recent Canadian Association of Laboratory Animal Medicine *CALAM/ACMAL Standards of Veterinary Care* (http://www.calam-acmal.org/content/StandardsVetCare.pdf).

The institutional veterinarian should report directly to the senior administrator of the institution. The institutional veterinarian should work with the ACC and facility manager to determine the appropriate level of veterinary services required, and as a minimum, ensure that an attending veterinarian visits the facilities at least twice per year.

Veterinarians attending farm animals should have special training in farm animal health management in research, teaching or testing environments. The attending veterinarian should report to the institutional veterinarian. The attending veterinarian should also work with the facility manager when recommending treatment or euthanasia. Wherever possible, the final decision of the veterinarian should involve consultation with the facility manager, principal investigator and the ACC.

The institutional veterinarian should be responsible for the development, implementation and oversight of an animal health program for each species maintained within the institution, and the maintenance of health records for each animal or group of animals. The herd/flock health program should delineate the responsibilities of the facility manager, attending veterinarian, animal care personnel, etc. in the prevention and treatment of diseases and injuries, and should include plans for administering treatment in the event that the veterinarian is not on site.

In the case of an animal found to be in unrelievable pain and distress, and where the facility manager and/or relevant investigator cannot be reached, the attending veterinarian must have sufficient authority to euthanize the animal.

### 2.4.5 Responsibilities of the ACC

**Guideline 8:**

**The animal care committee must approve all protocols to be conducted within its jurisdiction, no matter who will be conducting them (*CCAC policy statement on: animal-based projects involving two or more institutions*, 2003; *CCAC policy statement on: terms of reference for animal care committees*, 2006). The animal care committee must also review all studies that are conducted by investigators affiliated with their institution or agency, regardless of whether that project will be conducted within their jurisdiction or in the jurisdiction of another animal care committee.**

For studies involving the use of farm animals, ACCs should have a protocol form that addresses the following:

a) the objectives and significance of the research, teaching or testing activity, as demonstrated through scientific merit review, review of pedagogical value or regulatory requirements, respectively, by a qualified, informed peer review process independent of the ACC;

b) a thorough literature search to prevent unnecessary duplication of previous work or to encourage use of the most recent methods;

c) the availability or appropriateness of alternative procedures or models (e.g., less invasive procedures, cell or tissue culture, or computer simulations) for the proposed research, teaching or testing activity, and why alternatives are not being used; and

d) aspects of the proposed study relevant to the animals' care and use, including

   i) justification for the species and/or strain to be used;

   ii) justification for the number of animals to be used;

   iii) description of procedures that may cause pain, distress or discomfort, and proposed methods of alleviation (including anesthesia, analgesia and tranquillizers, and special housing conditions), as well as justification for any procedures involving unalleviated pain, distress or discomfort, and potential welfare impacts, in order to assign a category of invasiveness (Mellor & Reid, 1994);

   iv) appropriateness of procedures and post procedural care;

   v) criteria and process to establish endpoints (i.e. remove animals from the study and/or euthanize), including authority to euthanize animals found to be experiencing pain or distress that cannot be relieved;

   vi) any husbandry requirements that deviate from those recommended in these guidelines;

   vii) aspects of animal husbandry not covered under written Standard Operating Procedures (SOPs);

   viii) method of euthanasia and disposal of the animals;

   ix) responsibilities, training and qualifications of any researchers, teachers, students and animal care personnel involved in the proposed activities; and

x) efforts to best meet the social and behavioural needs of the animals.

ACCs should be aware of potential animal welfare concerns for the particular animals involved in the project. For protocols involving agricultural research, it should be realized that many strains of animals have been bred to meet a high capacity for production. While high production can be a sign of good welfare, in some circumstances high levels of production can increase risks to animal welfare. The most serious of these risks are leg disorders in cattle, pigs and poultry, and cardiovascular disorders in pigs and poultry. Care should be taken to ensure that high-producing animals are in good condition and managed in a way that ensures their welfare. A good assessment of animal well-being should be a requirement of any protocol. The production of individual animals (e.g., growth rates and milk or egg production) should not be increased to the point where the welfare of the animals is compromised (Mellor & Stafford, 2001).

ACCs should review and approve SOPs, in particular for standard agricultural practices that are used irrespective of the study. The practices must be

- warranted to sustain the long-term welfare of the animal and the safety of those involved in the handling or care of the animals;
- performed by, or under the direct supervision of, capable, trained and experienced personnel; and
- performed using techniques to minimize pain, stress and infection.

SOPs should be revised from time to time, in particular when research demonstrates improvements in husbandry procedures and production methods.

**Guideline 9:**

**Local animal care committees with farm animal facilities in their jurisdiction should include persons with relevant expertise with farm animals or should have access to an advisor(s) that would provide knowledgeable input.**

## 2.5 Regulations

Animal welfare in Canada is governed by legislative directives and voluntary standards of care which are defined and applied by governments and non-governmental organizations. A description of this network can be found at www.inspection.gc.ca/english/anima/trans/infrae.shtml.

### 2.5.1 Federal

The principal federal legislation covering farm animal welfare is contained in 1) the *Health of Animals Regulations* (Part XII), which regulates transport of farm animals; 2) the *Meat Inspection Act* (Sections 61-80), which sets standards for the humane handling and slaughter of food animals in federally registered slaughter facilities; and 3) the *Criminal Code of Canada* (Section 446), which prohibits willfully causing animals to suffer. The *Health of Animals Act* and *Regulations*, and the *Meat Inspection Act* are administered and enforced by the Canadian Food Inspection Agency (CFIA). Sections 444 to 446 of the Criminal Code are enforced by the various police forces, societies for the prevention of cruelty to animals (SPCAs) and humane societies.

Studies conducted in food animals using unregistered feed additives, vaccines or drugs may require approval of either the Veterinary Biologics Section of the CFIA, through the Permit to Release Veterinary Biologics, or the Veterinary Drugs Directorate of Health Canada, through the Experimental Study Certificate. Treated animals must not be released into the food or feed chain (including release for slaughter, rendering, or growth and fattening for eventual slaughter) without approval from federal regulators such as the CFIA, Health Canada and Environment Canada, depending on the application.

### 2.5.2 Provincial and territorial

All provinces and territories in Canada have legislation governing the care of animals. Legislation in the provinces and the Yukon aims specifically to prevent cruelty to animals. In the North West Territories and Nunavut, cruelty to animals is covered by their *Herd and Fencing Act*. Most provinces have additional legislation to govern transportation, slaughter and various aspects of standards of care. Provincial legislation concerning animal welfare is enforced by specifically appointed inspectors, police forces, the SPCA, or officers of other humane societies.

### 2.5.3 Non-governmental organizations and voluntary standards

Recommended codes of practice for the care and handling of various species of farm animals are available through the National Farm Animal Care Council (http://www.nfacc.ca/code.aspx). Since the early 1980s, industry stakeholder groups have collaborated in the development of these codes of practice. The codes are voluntary, but are referenced in some of the provincial Acts and are used as the standard for animal care by provincial inspectors. In addition, some animal producer groups have instituted programs of auditable standards for animal care following principles of Hazard Analysis Critical Control Points (HACCP).

Other non-governmental organizations also have significant mandates for farm animal welfare. The National Farm Animal Care Council (NFACC) addresses national animal care issues related to farmed animals, with a primary focus on animals raised for the production of food for humans (http://www.nfacc.ca). The Canadian Veterinary Medical Association (CVMA) includes animal welfare as one of its top priorities, and has produced a series of position statements on issues relating to animal care (http://canadianveterinarians.net). The Canadian Federation of Humane Societies (CFHS) works with stakeholders to improve the welfare of all animals, including farm animals, and represents over 100 humane societies and SPCAs (http://cfhs.ca).

Industry-driven councils in Ontario, Manitoba, Saskatchewan and Alberta promote responsible care of farm animals. In addition, British Columbia has a standing committee on the humane handling of farm animals, and Ontario has a working group on transportation of farm animals. The universities of Guelph, British Columbia and Prince Edward Island have specific programs to conduct research and train students in animal welfare, including farm animals.

# 3. FACILITIES

<u>**Guideline 10:**</u>

**Farm animal housing facilities should be designed to accommodate the scope and type of research, teaching and/or testing to be conducted.**

Facility design and the nature of the primary enclosures used for housing farm animals have a major impact on animal welfare. The design must take into account the physical, physiological and behavioural needs of the animals, the flexibility required to allow for variation in group and animal size, and the needs of those caring for and working with the animals. The specific requirements of breed types to be housed at the research facility should also be considered in the facility design.

Where a new facility or extensive remodelling of existing housing is contemplated, the plans should be discussed with agricultural engineering experts (provincial departments of agriculture, engineering consultants and regional agricultural colleges), as well as animal scientists, animal welfare experts and veterinarians. Baseline information on facilities and housing for farm animals for production purposes may be found in the *National Farm Building Code of Canada* (NRC, 1995), the American Society of Agricultural and Biological Engineers' *ASABE Standards 2008: Standards Engineering Practices Data* (ASABE, 2008), and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers' *2005 ASHRAE Handbook-Fundamentals* (ASHRAE, 2005). In addition, the CCAC Assessment Sector can be consulted to ensure compliance with CCAC policies and guidelines.

## 3.1 Types of Facilities

There are two basic types of housing for farm animals in the Canadian climate: naturally and mechanically ventilated animal housing. For both types, proper design and maintenance are important to ensure an acceptable environment for the animals.

The choice of housing type should be based on the species, climate, available technology and intended use. For example, production research will have housing similar to that of industry but with confinement facilities that are more versatile than generally found in industry. Similarly, vaccine testing may be carried out under normal production system conditions, in order to determine efficacy in typical environmental conditions. Animals used for biomedical research will likely require indoor housing where the environment can be fully controlled.

### 3.1.1 Agricultural production research and teaching

When animals are kept for research pertinent to agricultural production or for teaching at agricultural institutions, commercial production practices will often be used to maintain relevance to the industry. In these situations, the national industry recommended codes of practice for the care and handling of farm animals (http://www.nfacc.ca/code.aspx) should be viewed as minimum acceptable standards, and the best industry standards should be used. Where these standards deviate from CCAC guidelines, their use should be approved by the institutional ACC.

A management practice or housing method can negatively impact the welfare of the animals. A given practice or type of housing commonly used in industry can not always be assumed to be acceptable for animals kept for research or teaching purposes. Use of practices with negative impacts must be justifiable in terms of the research or testing to be performed or the type of teaching program.

### 3.1.2 Biomedical research

Where agricultural animal species are used in biomedical research projects and teaching demonstrations, they should be kept in facilities compatible with each animal's species-specific requirements and under conditions that will minimize stress. Conditions should be similar to those required for non-agricultural species used in similar experiments, to ensure appropriate levels of sanitation and disease control.

## 3.2 Engineering and Design

### 3.2.1 Location of facilities

In determining the location of new farm animal facilities, the following factors should be evaluated: vehicle access, feed and water supply, utility services, drainage and sufficient space for expansion. Given the nature and size of agricultural facilities, local environmental concerns must be considered. Provincial ministries of agriculture and environment, as well as local authorities, should be consulted to ensure that all relevant laws and regulations are followed. Consideration needs to be given to manure containment, the type of manure handling system, the nature of the manure (liquid or solid), surrounding population and zoning, neighbouring residents, and how the processed or stockpiled manure is to be disposed. Disease transmission between animals in adjacent facilities through exhaust air, and ease of maintaining high standards of biosecurity, must also be considered.

### 3.2.2 Basic components of a farm animal facility

**Guideline 11:**

**Housing should provide each animal with a safe area with adequate access to nutritious feed and fresh water; an appropriate, comfortable, bedded and well-drained lying area; suitable surfaces for walking; shelter from adverse weather; and sufficient space to interact socially (including space for subordinates to escape from dominant animals).**

Facilities for housing farm animals should provide acceptable air quality and appropriate space to meet the animals' physical and behavioural needs. These needs and the means to accommodate them will vary according to climate and species; however, farm animals generally require the following:

- fenced, penned or enclosed areas with water troughs and feeders, and sufficient space for the animals to eat, drink, rest, sleep, move about, urinate and defecate, including areas for exercise and access to the outdoors whenever possible;
- sheltered areas for protection from excessive solar radiation, hot or cold temperatures, wind, rain and snow; and
- specific accommodation, as needed, for young animals, breeding males and females, maternity care, chick hatching, species separation, work animals (e.g., horses and dogs), and sick and injured animals.

Facility design should also address the following components (based on FASS, 1999):

a) Husbandry activities

- movement of staff while carrying out required tasks;
- space and proper facilities for handling, sorting, weighing, loading and unloading animals (e.g., corrals, gates, pens and chutes);
- storage of feed and bedding; and
- quarantine of animals.

b) Water supply

- equipment to provide clean and potable water in sufficient quantities and at an optimal temperature for the animals, as well as water for sanitation, experimental, fire and emergency purposes; and
- provision of water in case of freezing or interruption of supply.

c) Electrical services

- necessary electrical services, including an emergency generator protected from moisture, and an alarm system.

d) Manure

- storage and handling of excreta and contaminated drainage water, and their removal from the animal space as soon as possible.

e) Equipment

- storage of animal handling equipment;
- equipment for adding medication to the water, as needed; and

- equipment for cleaning and disinfecting the equipment and the building (some pieces of equipment, such as the drinking trough, must be rinsed before being used by animals).

f) Medical

- veterinary examination and treatment space; and
- secure storage of medical supplies at the proper temperature.

g) Research activities

- space for storage and use of laboratory and office instruments;
- space for experimental surgery (including pre-operative preparation and post-operative recovery), if appropriate; and
- storage of records.

h) Teaching activities

- areas for observing and individual handling of animals, and for discussion.

i) Other

- storage of toxic materials and hazardous substances;
- semen collection, storage and artificial insemination;
- slaughter and processing facilities;
- toilets, showers and change rooms for staff;
- effective storage or removal of carcasses; and
- carcass composting or incineration.

In addressing the space requirements, consideration should also be given to whether the activities will occur on a regular basis or periodically, and whether some activities can be carried out in a multi-purpose area. In general, different functions should be carried out in separate areas. If areas are used for multiple functions, how the different functions are to occur should be defined in an SOP.

### 3.2.3 Biosecurity

Biosecurity refers to measures to keep disease agents away from the animals, and should be considered in the design of farm animal facilities. The degree of biosecurity will depend on the animals' susceptibility to disease and the intended experimental use of the animals. Measures may include outside security fences and an entry alarm system. Warnings to visitors should also be posted. Within the facility, a physical barrier should be established between the animal housing/production/experimental area and the visitor area. This barrier can be a walk-through shower facility or a step-over partition with foot bath, hand washing facilities and clothing/footwear changes to be used in the facilities; however, plastic boots are often adequate. Where farm animals need to be housed in fully-enclosed buildings, a biosecure barrier should be in place to separate the animal space from the outside or adjacent areas containing pathogens, rodents, aerial contaminants and pests. A biosecure barrier could include filtering inlet air to prevent entry of outside contaminants/pathogens, use of physical barriers, and ventilation systems dedicated only to the animal areas.

Biocontainment must also be in place to protect wildlife from contact with experimental animals which may have been deliberately infected with disease.

For outside confinement of animals, security from predators such as dogs, coyotes and others should be included. Though this may be hard to accomplish, steps to discourage predation and vandalism are important.

### 3.2.4 Materials and finishes

Materials and finishes should be suited to the use of the facilities, taking into account the safety of the animals and the required sanitation processes. The materials should be durable and suited to the behaviour of the animals to be housed. Some animal behaviour could result in structural damage (e.g., chewing, mounting, fighting, kicking and escape attempts), and this should be taken into account.

For indoor facilities, surfaces should be impervious, easily sanitized, and resistant to water and chemicals used in their sanitation. There are various plastic laminates available which, although expensive, serve this purpose extremely well and could be used to cover the walls and ceiling. Areas that will be in contact with wet and corrosive substances (e.g., animal manure, acidic silage or cleaning solutions) should be resistant to these (FASS, 1999). All materials should be fire resistant.

Wood is a warm, non-abrasive material with some resiliency. Where the surface is roughened through use, it may not be easily sanitized. Unpainted wood is acceptable for many applications, except when treatment for structural damage and insects is not possible, or where it is in direct contact with the ground (FASS, 1999). If paints or glazes are used, they should be non-toxic, lead-free, mould resistant and durable, particularly where cleaning agents, scrubbing and high pressure sprays are used (FASS, 1999).

Penning and all materials to which animals have access should not contain harmful chemicals (e.g., wood preservatives), and should be capable of being cleaned and disinfected. Penning should not contain any sharp surfaces likely to cause injury, and should be sufficiently strong to prevent escape.

### 3.2.5 Doors

Entry to the animal facilities should be secured. This can be in the form of perimeter security, entry locks and/or entry alarms.

Doors should fit tightly and be kept closed in order for the room ventilation equipment to operate as designed and to prevent access by vermin. To observe animals in enclosed rooms, observation windows with covers should be installed in walls or access doors to animal rooms.

### 3.2.6 Walls and ceilings

In enclosed animal facilities, walls and ceilings should be durable and able to withstand the impact of the animals, along with the corrosive effect of humidity, manure and manure gases. Ceilings should be of sufficient height to allow safe and free movement of animals and research staff.

### 3.2.7 Floors

**Guideline 12:**

**Flooring should provide a dry, comfortable lying surface; it should allow animals to go through their normal movements and postural changes without slipping, and it should not result in injuries.**

Earthen floors are acceptable in sunshades, open (run-in) sheds, pens or shelters where climate, animal use and management intensity permit a firm, dry, easily cleaned base support (FASS, 1999).

Barn floors should be slip-free and not abrasive to the animals' feet. The slope of the floors should range between 1 and 4% to ensure proper drainage (FASS, 1999). For ramps and other areas where animals may be likely to slip, slip-resistant grooves or cleats should be incorporated.

Solid concrete floor surfaces for farm animal facilities should be finished in a manner that will minimize slippage and thus the probability of injury and bruising. The finish of concrete floors can range from a polished steel trowel finish for baby pigs, to a broom finish for larger animals. If slatted or partially slatted floors are used, the slat width and spacing should vary with species to provide adequate support and minimize the risk of injury, while permitting good passage of manure through the slots.

Use of concrete flooring increases the risk of hoof and leg damage. Whenever possible, attempts should be made to minimize direct contact between animals and concrete flooring (e.g., by using non-slip rubber flooring and/or bedding), particularly in animal holding stalls and treatment pens.

### 3.2.8 Manure handling

**Guideline 13:**

**All provincial and local laws and regulations with respect to manure handling must be followed.**

Manure handling systems are an important component of the floor design in a farm animal facility. The possibility that toxic gases such as hydrogen sulphide may develop from liquid manure disposal systems during discharge must always be considered, as these gases can be dangerous both to livestock and personnel. Ammonia and odour emissions occur where manure/urine dries on solid or perforated floor surfaces.

Manure should be removed from the building as soon as it is produced.

There are a number of designs for manure handling systems, including slatted floors and grates, and mechanical scrapers or hydraulic flushing systems to clean the floors, gutters or manure channels. The system used should allow for separation of the animals from their excreta, with the exception of poultry housed in floor pens where this is not possible due to the activity of the birds. Any manure slots and gutters should be sized and spaced to prevent hoof or lower leg injury of animals.

#### 3.2.8.1 Manure management

Open outside manure storages should be surrounded by a security fence complying with environmental standards set out by the municipal, provincial or federal agencies. Interior manure collection pits should be isolated from the animal housing area and properly vented. Gas traps should be used to prevent manure gases from moving from the collection area to the animal housing area via the manure gutters.

## 3.3 Animal Environment

### 3.3.1 Lighting

The effects of ambient light on the welfare of farm livestock are largely unstudied. The intensity and duration of ambient light should meet the species-specific preferences of the animals as far as possible. In general, sufficient light intensity should be provided to permit observation and care of the animals. It is not acceptable to simply turn on lights for a short period each day during cleaning duties or observation, and leave them off at other times; nor should lights be left on continuously.

### 3.3.2 Ventilation

<u>**Guideline 14:**</u>

**The environmental control system should provide an acceptable thermal (temperature and airspeed) and non-thermal (air quality) environment throughout the animal's life.**

The combined effect of temperature, relative humidity and airspeed create the thermal environment perceived by the animals. An acceptable thermal environment permits the animals to perform any normal activities for their species comfortably, as well as any additional activities that are part of the scientific protocol.

The environment of the indoor animal space (air velocity, air temperature and air quality) can be controlled by the exchange air provided by mechanical ventilation (ceiling or wall mounted exhaust fans) or by natural ventilation (thermal buoyancy and wind forces). Smaller animal housing normally includes a mechanical ventilated system and a supplemental heating system, while large animal housing may include a natural ventilated system without a supplemental heating system. The ventilation system should ensure that fresh air is introduced to the animal space at airspeeds near 0.25 m/s during minimum ventilation. Air speed requirements will vary for different species, ages and stocking density, and depend on whether the ambient temperature is above or below the animal's thermoneutral temperature requirements.

Mechanically-ventilated farm animal housing commonly uses exhaust fans to maintain indoor temperature during warm weather or to provide a minimum amount of ventilation to maintain acceptable air quality for the animals and personnel. Supplemental heating is provided when the set minimum ventilation rate allows the indoor temperature to decrease below the desired set-point temperature. Temperature sensors should be placed in a location in the room that accurately represents the conditions to which the animals are being exposed. The height of sensors and their location in relation to doors, ventilation ducts, etc. needs to be considered in order to attain an accurate assessment of the animals' thermal environment.

In mechanically-ventilated animal housing, the distribution of incoming fresh air into the building is critical to the comfort of the animals. Planned air inlets must be located in the walls or ceilings to distribute and project fresh air into the building airspace so that each animal space is diluted by fresh air at room temperature. Poor mixing of incoming air may mean that some animals experience excellent air quality while others are exposed to poor air quality (drafts or stagnant air). The distribution of incoming fresh air is largely controlled by automatic adjustment of the air inlets, based on static pressure or operating fan capacity. The building should be well sealed to prevent air from entering through openings other than planned inlets. The instrumentation suggested in Section 3.3.3 should be considered to evaluate air quality. Heating systems must be designed to provide adequate heating during cold weather conditions and during periods of low stocking density. A supplemental heating system should therefore be sized by a professional engineer so that an acceptable temperature can be maintained at the minimum ventilation rate. The minimum ventilation rate will ensure that the level of atmospheric contaminants (including moisture, ammonia, respirable dust and sulphurous compounds) is diluted to an acceptable level. Further guidance on ventilation is provided by ASABE (2008) and ASHRAE (2005). Insulation and vapour barriers are critical to minimize structural rot and ensure condensation does not accumulate on wall, ceiling or foundation surfaces (preventing fungal growth).

Infrared heat sources above floors can result in uncomfortably high floor surface temperatures, even when the ambient temperature above the floor meets the animals' requirements. This commonly occurs in heated creep areas for housing nursing piglets.

Naturally-ventilated animal housing is suitable for larger animals where environmental control, such as minimizing drafts and maintaining temperature and air quality, is more difficult or of less importance (e.g., pigs in straw-based naturally-ventilated systems). This housing system provides primary environmental modifications designed to protect the animals from solar radiation, wind, snow, rain and temperature extremes. Strategically placed openings throughout the building should be provided to ensure that ventilation resulting from wind or thermal buoyancy is adequate to maintain acceptable air quality. These openings can be adjusted to maintain a desired indoor temperature. Trees should be planted or placed at least 24 m away from these buildings to optimize their natural ventilation. During hot weather, the shelter acts as a sunshade, and additional openings then facilitate natural air movement through the animal space.

In the event of high ambient temperatures, provisions for cooling should be considered. Cooling systems (e.g., high and low pressure misters, drip and cooling pads, and cooling fans directed at the animals) are available for different animal species. For animals confined outdoors, shade trees or structures should be provided.

### 3.3.3 Environmental measurement

To measure the thermal and non-thermal variables that may compromise an animal's well-being, and to troubleshoot problems, the following instrumentation should be used. These instruments should be available within the facility or be accessible to the facility manager when needed.

- *Electronic fast response thermometer* – Temperature fluctuations in a horizontal or vertical direction indicate poor air mixing, or that some areas are over ventilated while others are under ventilated. Temperature sensors should not be placed where there is a radiant heat source.

- *Infrared thermometer to measure surface temperature* – The surface temperature will give an indication of the radiant heat exchange between the animal and the radiant heat source. The surface temperature of floors, hot water pipe, walls and foundations can be easily checked.

- *Min/Max thermometer* – Measures of minimum and maximum temperatures provide an indication of the degree of control of the barn airspace temperature. Large differences between minimum and maximum temperatures suggest poor heating or ventilation control.

- *Relative humidity hygrometer* – Relative humidity measurements give an indication of the water vapour concentration of the air. Relative humidity over 70% can result in wet litter conditions. If the room air is not well mixed, high humidity areas can occur near the corners or end walls of the room.

- *Air velocity meter* – A hot wire anemometer is commonly used to quantify air movement in an animal space. Speeds exceeding 0.25 m/s at the set-point temperatures can result in cold stress for smaller animals.

- *Smoke pencil* – Troublesome drafts can be visualized by forcing air through a small chemical-filled glass tube, creating a white chemical smoke. This smoke shows the direction and speed of a local draft. Smoke pencils also can be used to locate any unplanned air inlets (e.g., cracks around doors).

- *Gas detectors to spot check carbon dioxide, ammonia and hydrogen sulphide* – Bellows or pump-type gas detectors are commonly used. A measured amount of sample air is drawn through a glass tube packed with a chemical that progressively changes colour in response to a specific gas. The chemical tubes have graduated scales that are matched to the length of the coloured column. Generally, representative readings are obtained near the centre of the room.

- *Dust particle size counters* – Dust particle size counters should be used when respirable dust levels are thought to be high. Normally, visible dust is in the non-respirable size range.

## 3.4 Safety

### 3.4.1 Electrical

All electrical fittings should be waterproof so that each room can be pressure-washed.

Proper connection of the electrical equipment to ground potential is essential. This protects individuals from stray current flowing from an electrical device through the individual to the ground. A proper ground wire provides an alternate path for the current to flow to the ground in the event of a hot wire touching the housing of an electrical device. Periodic checks should be made to ensure the electrical equipment is in good condition and the system has not been overloaded. In wet locations and areas subjected to pressure-washing, power sources must have Ground Fault Circuit Interrupters (GFCI), and non-metallic conduit and water-tight lighting fixtures must be used. This applies both inside and outside of buildings.

### 3.4.2 Manure gases

Personnel working in barns should be trained to deal with emergency procedures related to noxious manure gases. Use of a self-contained breathing apparatus may be required where $H_2S$ gas or ammonia concentration becomes excessively high due to failure of manure handling or ventilation systems.

## 3.5 Emergency Preparedness (Prevention and Action)

**Guideline 15:**

**All facilities must have sufficient capacity to handle emergencies, including the capability to maintain acceptable air quality, temperature and water supply.**

**Guideline 16:**

**A proper alarm system and associated Standard Operating Procedures addressing emergency circumstances must be in place. Checklists should be established to ensure that testing, preventive maintenance and servicing occur at frequent and regular intervals.**

Sufficient redundancy in environmental control systems should be in place to ensure that temperature and air quality remain at acceptable levels. For medium to large livestock facilities, back-up power is essential. However, for smaller facilities with fewer animals, as in quarantine barns or specialized facilities, stand-by power generation may be impractical. In these situations, alarm systems are essential, and removable (breakout) panels to facilitate air exchange and SOPs addressing emergency feed and water supply should be in place.

In all facilities, regardless of size, alarms are required. Temperature sensors should be installed in a confined animal space and connected to an alarm system which will give warning if the ambient temperatures are unacceptable. The alarm system must notify a responsible person that there is an emergency so that appropriate remedial action is taken quickly.

### 3.5.1 Fire prevention

Facilities must work with local fire authorities and have fire prevention policies and procedures in place; this includes a ban on smoking in and around facilities, proper storage of combustible materials, assurance that machinery wiring and electrical equipment are in good repair, sprinkler systems, fire extinguishers, and evacuation procedures for people and animals. *The National Farm Building Code of Canada* (NRC, 1995) is a reference source for firewall construction and fire protection.

## 3.6 Specialized Facilities

### 3.6.1 Feed and bedding storage

Appropriate designated areas are needed for storage of feed and bedding supplies (including hay, silage and straw) such that they remain dry and free of insects, rodents, mould and mildew. Large supplies of feed should be stored in bulk feed tanks. Feed in bags should be stored off the floor on pallets or racks. Feeds stored outdoors are susceptible to moulds and spoilage if the bags are stored on wet surfaces or become punctured.

### 3.6.2 Quarantine facilities

Quarantine facilities should be physically separate and have separate air handling systems, facility-specific equipment, and SOPs to minimize the spread of pathogens. Quarantine areas should be designed to facilitate observation. In instances where strict biosecurity measures are necessary, quarantine areas should have separate access and a containing airlock room. To facilitate infectious agent control practices, these facilities should include footbaths, hand washing stations, dedicated accessories and hand implements, and clean to dirty traffic flow. Air inlets fitted with screens or filters may be used to reduce the incidence of infectious agents or insects entering an animal confinement facility. Consideration should also be given to storing sufficient quantities of forage and bedding.

### 3.6.3 Exclusion facilities

To protect the health status of animals such as immunocompromised animals and valuable genetically-engineered animals, exclusion facilities or barrier housing that prevent infectious agents from entering the barrier may be required (*CCAC guidelines on: laboratory animal facilities – characteristics, design and development*, 2003b).

### 3.6.4 Containment facilities

Biocontainment or inclusion barriers are used to prevent the escape of agents of disease from animals in a unit to the outside. Maintaining large animals in containment poses a variety of special requirements, for example, large volumes of manure will require pre-treatment to eliminate infectious agents prior to disposal in a sewage system.

Biocontainment is required for all animal work involving pathogens listed by the Canadian Food Inspection Agency (CFIA) and the Public Health Agency of Canada (PHAC). Information on biohazard classification should be sought from the CFIA Biohazard Containment and Safety Division (see http://www.inspection.gc.ca/english/sci/bio/bioe.shtml). The level of containment required depends not only on the risk to human health, but on a variety of other factors including the prevention of cross contamination and the prevention of escape of animal pathogens into the environment (see AAFC, 1996 at http://www.inspection.gc.ca/english/sci/lab/convet/convete.shtml). The physical requirements for the various levels of biocontainment are described in *Containment Standards for Veterinary Facilities* (AAFC, 1996).

Biocontainment measures are also required for work with genetically-engineered animals (see Section 9.8.3 Livestock derived from biotechnology – Regulations).

### 3.6.5 Post mortem facilities

A designated area and associated SOPs are required for processing carcasses for necropsy and/or disposal, and appropriate sanitary practices should be followed. For post mortem facilities

- the area should be designated and secure (locked);
- the facility should not be used for other purposes and should preferably have an anteroom;
- floors and all other surfaces should be impervious and easily sanitized;
- infection control measures should be taken; and
- a record should be kept of the animals being held in the facility.

*CCAC guidelines on: laboratory animal facilities – characteristics, design and development* (CCAC, 2003b) describes the requirements for a necropsy facility. In particular, if the necropsy area is to be used to collect tissue from animals of unknown health status or to diagnose the cause of death, then a proper necropsy suite should be included in the animal facility. The design of the necropsy suite should facilitate safe and efficient carcass handling, as well as thorough cleaning and disinfection (including fumigation if required). If used for large animals, the necropsy suite is subject to frequent wash downs, and large quantities of water are used on a regular basis. Floor drains are essential, with baskets to capture materials that should be collected for disposal (by incineration) and not permitted to enter the sewer system.

# 4. FACILITY MANAGEMENT

## 4.1 Maintenance

**Guideline 17:**

**Facilities must be maintained to a high standard. Standard Operating Procedures should be developed specifically for the facility, describing cleaning and disinfection of facilities and equipment, including animal housing pens.**

The facility manager must have the engineering specifications of the facility available, as well as the operating manuals for any special installed equipment (e.g., computer control systems).

A regular maintenance plan must be in place for the facility buildings, in order to prevent leaks, deterioration of surfaces, etc. Equipment used for cleaning and disinfection should be maintained by qualified personnel that have received specific training. Some pieces of equipment, such as the drinking trough, must be rinsed before being used by animals. Equipment that adds medication to the water must be in good operating condition and must receive appropriate maintenance to avoid under/over dosage.

A documented preventive maintenance program is required for all life support systems (e.g., heating, cooling and ventilation), and an inventory of spare parts for all essential facility components should be maintained. Procedures should be in place for delivering essential husbandry services (e.g., feed, water and manure removal) on a temporary basis when the equipment fails or is shut down for repair.

Procedures should be in place for reporting any deficiencies to the facility manager, including the need for repair of equipment used for effective husbandry. Facilities must have a method for assuring a rapid emergency response by staff outside of normal operating times.

**Guideline 18:**

**Facility staff require specialized knowledge, experience and training for proper function, operation and maintenance of the facility.**

## 4.2 Feed, Water and Bedding

Mechanical systems that deliver feed and water should be inspected at least daily to ensure that they are in good working condition. Inspection logs should be maintained. Emergency SOPs should be developed that describe procedures to follow in the event of failure or contamination of the water supply or failure of the feed delivery system.

Feed and bedding storage areas must be well maintained and cleaned on a regular basis to prevent water contamination, access for pests and mould growth.

An effective program of vermin control is particularly important in the feed storage areas. Toxic compounds should be stored outside of the feed room and animal quarters in a secured space. Baits placed for the control of vermin should be in spill-proof containers designed to eliminate access by non-target animals.

**Guideline 19:**

**Programs for vermin control should be in place to deal with invertebrate and vertebrate pests. Safe, humane and environmentally sound methods of pest control should be used.**

Exclusion should be the primary means of pest and predator control. For indoor facilities, all openings should be screened and any cracks sealed. Screen with 1.3 cm mesh is suitable for openings, while screens with 1.9 cm mesh can be used for ceilings with ridge vents to deter entry by rodents and birds (FASS, 1999). Mesh size used for ceilings may be smaller than 1.9 cm, providing it does not interfere with proper air flow (FASS, 1999). Consideration should also be given to installing mesh below ground along building foundations, particularly where these are made of wood (FASS, 1999).

If pests or predators cannot be controlled by exclusion alone, a non-lethal means of predator control should be used as the first line of defence, and employees should be trained in the methods that work best in the local area. If lethal methods must be used, they should be as humane as possible. Leg-hold traps, body-gripping traps, snares, glue traps and painful poisons such as strychnine and 1080 should not be used as they may cause severe and prolonged pain and distress.

The use of cats is discouraged, in particular because of disease concerns. Where animals such as cats are used for pest control, they must be appropriately cared for (e.g., spayed or neutered, and regularly vaccinated, dewormed, etc.). Due to the biosecurity risk, these animals should be confined to the facility where they are used.

## 4.3 Excreta Management and Sanitation

All animal facilities must have properly designed systems for managing excreta in order to maintain acceptable health conditions for both the animals and the people working in the facilities. These systems must comply with federal, provincial/territorial and municipal regulations for the prevention of water, soil and air pollution.

For livestock kept outdoors, an appropriate bedding/manure pack should be maintained by adding straw and removing the bedding/manure pack material when ambient temperatures cause a thaw. Manure/mud/bedding pack build-up at feed bunks should be kept well below the knees of outdoor housed bunk-fed livestock. When removed, the manure/bedding pack should be transported to a composting site with land management to prevent run-off.

## 4.4 Environmental Control and Monitoring

Ventilation plays a key role in the health and welfare of both animals and workers, and staff should be familiar with behavioural signs of thermal stress in animals. The ventilation and air quality system of the unit should address the following:

a) Air movement is a key aspect of thermal comfort for animals. For vulnerable animals of any species, such as neonates, the newly weaned, and sick animals of any age, there should be no detectable movement of the air (0.25 m/s) at the level of the animal (i.e., no air movement should be felt on the back of a wet hand). Bedding, covered areas, and small, enclosed areas (hutches) allow animals to avoid drafts in a local micro-environment. Checks should be made for signs of shivering, huddling and piling.

b) Ammonia build-up in the animal space, especially from urine and manure exposed to the air, is a common cause of irritation and/or potential health problems for farm animals and staff. In the interests of animal welfare, ammonia levels should be less than 10 ppm (FASS, 1999), although current occupational regulations to protect worker health and safety specify the exposure limit to ammonia as 25 ppm (NIOSH, 2007).

c) Dangerous gases, especially hydrogen sulphide and methane, can build up in manure pits under certain conditions, and can lead to severe health problems and death of animals. They can also build to explosive concentrations. Precautions are needed to protect animals and personnel, especially when manure is discharged from under-floor storage pits.

d) Very fine, invisible "respirable" dust, usually generated from dry fecal material, is common in swine units. Its effects on livestock health are not well understood, but it is a recognized health hazard for humans. Keeping levels of respirable dust low enough to prevent symptoms in workers and visitors (coughing, excessive mucous production or general malaise) is probably adequate for animal health. On-going or recurring respiratory irritation among workers indicates a problem that must be resolved. High respirable dust levels may also be indicative of high endotoxin levels. Measures to control non-respirable dust, which consists mainly of larger, feed-derived particles that settle on exposed surfaces, will not necessarily help solve problems of respirable dust.

e) Relative humidity should be low enough to avoid condensation and damp conditions in the building; however, excessive dryness may also create problems. For most enclosed animal houses, 40-60% relative humidity is a good rule of thumb.

If sensors are used to regulate environmental control systems, they should be placed where they will detect the micro-environment of the animals (FASS, 1999). Sensors should be maintained and calibrated on a regular basis.

To maintain effective operation of the heating, ventilation and air conditioning (HVAC) system, the controllers should be properly staged. Responsibility for the controllers should reside with the facility manager. Where fans or power-controlled openings are used for ventilation, a warning device and a back-up system (e.g., generator or automatically-opening wall ports) are required to ensure adequate ventilation is maintained in the event of a power failure.

Regular maintenance of the HVAC system must be undertaken to keep it in good working order. Mechanical systems (e.g., ventilation) should be inspected at least daily to ensure that they are in good working condition. Inspection logs should be maintained. Mechanical ventilation systems (i.e. fan blades, sensors, etc.) must be cleaned regularly because of dust accumulation. Lethal temperatures can occur quickly in mechanically ventilated barns if the ventilation system fails in hot weather.

Emergency SOPs should be developed that describe procedures to follow in the event of fire, flood or failure of the electrical supply. Examples are given in the national industry recommended codes of practice for the care and handling of farm animals (http://www.nfacc.ca/code.aspx). These should be posted, and staff should be familiar with the procedures.

## 4.5 Electrical Systems

Electric generators and other emergency equipment should be checked and maintained regularly to ensure they are operational. As a rule, generators should be inspected at least annually, and started monthly. Service logs should be kept in a visible place. Proper grounding of electrical equipment, and periodic checks to ensure that the electrical equipment is in good condition and the system has not been overloaded, will help reduce the occurrence of stray voltage.

## 4.6 Security, Access, Biosecurity and Risk Management

Research facilities should include biosecurity measures, varying in rigour depending on the status of the animals housed and the type of work undertaken. Appropriate signs should be posted indicating restricted entry.

Considerable planning is necessary to anticipate the problems that develop in a farm animal facility, and to develop systems and strategies to minimize the consequences of breaches in biosecurity. The strategies employed will depend on the size and type of facility, but should include a rapid emergency response by staff during and outside of normal operating times.

Biosecurity must be a priority since research and teaching institutions often face the added challenge of public access while needing to maintain a stable health status in their herd. A facility entry protocol should be developed, and strictly enforced, that covers staff, animals and visitors. Visitors should not be allowed into biosecure facilities unless absolutely necessary. If they have been in contact with other animals of the same species, in general they should not enter the facility for at least 24 hours (can be up to 72 hours, depending on disease risk). Facility personnel coming into contact with animals or facilities, and personnel who deliver animals to markets or slaughterhouses must be trained in biosecurity and appropriate procedures to mitigate risks of disease transfer. Appropriate SOPs should be in place for each facility.

Depending on the level of biosecurity required, on-site establishment of a barrier between visitors and animals can be achieved by a number of means involving both facility design and required procedures, including footbaths (see Section 5.3 Quarantine for footbath requirements); a step-over barrier with visitors washing their hands, leaving their footwear on one side of the barrier, and stepping over the barrier into footwear provided; or complete shower-in and change into on-site clothes and footwear. In addition, all visitors should arrive with clean clothing, footwear and equipment, which has not been in recent contact with other animals or animal facilities. For sites with multiple animal confinement facilities, the site area must be assumed to be contaminated, thus separate footwear must be provided in each facility.

Inter-building transfer of microorganisms can be reduced by careful attention to traffic patterns of personnel between buildings and potential pathogenic organisms in feed and transport vehicles. Incorporation of disinfectant footbaths, changing clothes or complete showering-in can be effective barriers to inter-building microorganism transfer by personnel. Cleaning and disinfecting transport vehicles after each use should be routine. Precautions for commercial feed delivery or animal transport vehicles are essential to minimize the likelihood of inter-farm disease transfer. Equipment used for the handling of feeds should not be used to collect animal wastes, unless procedures are followed to ensure appropriate sanitation between uses.

For containment facilities, appropriate clothing, gloves, respirators, etc. must be available and used, depending on the agent involved. SOPs must be in place to ensure the correct procedures are followed to maintain a functional containment barrier, including the use of clothing and specialized equipment.

# 5. ACQUISITION, TRANSPORTATION AND QUARANTINE

## 5.1 Acquisition

**Guideline 20:**

**Animals should be obtained from reputable sources with good health management, and animals should have known health status.**

In the interest of obtaining high quality animals for research, teaching or testing, animals should be sourced only from reputable suppliers with good health management. The animals should be carefully screened and new arrivals quarantined to ensure they are healthy before introduction to the main population (see Section 5.3 Quarantine). It is also important to obtain detailed information on the rearing methods, husbandry (feeding and grouping) and previous treatments performed (e.g., beak trimming, tail docking, etc.).

Different genotypes have different environmental and management requirements which must be taken into consideration in the selection of farm animals for use in research, teaching and testing, whether that use is agricultural or biomedical in nature. In particular, farm animals have undergone genetic selection to maximize production characteristics to the point that there is a growing concern over the impact of selective breeding of farm animals on their welfare (anonymous, 1998; Rauw et al., 1998). For example, fast growing broilers suffer from an increased incidence of leg problems and cardiovascular problems (e.g., Scientific Committee on Animal Health and Animal Welfare, 2000; Bradshaw et al., 2002). Therefore, unless it is necessary for the purposes of the experiment, it may be advantageous to use slower growing lines of animals.

## 5.2 Transportation

The movement of all animals should be in accordance with the *Recommended Code of Practice for the Care and Handling of Farm Animals – Transportation* (CARC, 2001; http://www.nfacc.ca/code.aspx), and must be in compliance with Part XII of the Federal Health of Animals Regulations (http://laws.justice.gc.ca/en/H-3.3/C.R.C.-c.296).

### 5.2.1 Acclimation

**Guideline 21:**

**After transportation, and before use in any experiments, animals should be acclimatized to the experimental conditions.**

Animals should be brought into clean facilities and undergo a period of acclimatization prior to being included in any research project; this can be combined with the quarantine period (see Section 5.3). A combined approach for acclimatization and quarantine should be used as far as possible, so that both are accomplished simultaneously. The time required for acclimation will depend on a number of factors, including species, age, previous environmental conditions, feed intake, etc.

When farm animals are brought to the laboratory or into indoor, heated housing, consideration must be given to the transition from the ambient conditions (e.g., cold weather and photoperiod), so that the animals experience a transition period that is as comfortable as possible. Bringing animals in from the cold will result in physiological changes (e.g., hyperventilation in sheep and perspiration in cattle) that will also be reflected in changes in their dietary requirements. Husbandry procedures, such as shearing sheep or clipping an excessively long hair coat (dairy cattle), will help to acclimatize the animals to a warmer environment. Other issues also require planning, including dietary changes (e.g., pasture to stored forages, requiring gradual phase-in of the new diet), increased handling, familiarization of the new environment and re-socialization of animals into new groups. The time required for the animals to adapt to the laboratory environment will vary. The transition back to outdoor farm conditions following laboratory confinement also requires careful planning, not only with respect to the ambient climate, but also with respect to regrouping of the animals, depending on the species. Consideration must be given to the animals' prior experience (degree of handling and nature of confinement).

A longer period of adjustment/training must be considered if animals are not accustomed to handling or observation prior to entering the laboratory.

## 5.3 Quarantine

**Guideline 22:**

**The goal of quarantine is to monitor and ensure the health of the animals, and thereby protect the health of conspecifics already resident at the facility.**

**Guideline 23:**

**Extra vigilance should be paid to monitoring the animals and to maintaining good records, in order to detect and respond to any health problems in quarantined animals.**

Quarantine is primarily a measure to ensure that animals are isolated and sanitary measures are put in place to ensure there is no transfer of pathogens to other animals in the facility. The purpose of quarantining newly received animals is to isolate them from the main populations in the facility to permit careful observation and health screening until the new animals are deemed to be healthy, free from communicable disease, and have a health status compatible with the resident population. Thereafter, these animals can be integrated into the herd/flock or placed on experiment. Quarantine can also be used to isolate populations of animals within the facility that become sick. Frequent inspection of animals under quarantine is necessary, and appropriate remedial measures should be taken for those animals which arrive at the experimental facilities injured or otherwise in ill health.

Recorded observations of water and food consumption and the animal's physical appearance and behaviour should be made. The animals should be observed at least twice daily by competent staff. When there is doubt regarding the health of the animals, their body temperature should be recorded. There should be pre-established measures to intervene if necessary.

Minimum quarantine times should be established in consultation with the veterinarian, based on the anticipated time frame for expression of the pathogens of concern. New stock animals should undergo routine health screening if they are to be mixed with existing stocks.

**Guideline 24:**

**Quarantine areas should be managed according to rigorous infectious agent control practices.**

SOPs should be in place to implement infectious agent control practices. Particular vigilance should be paid to practices such as effluent disinfection, use of dedicated accessories, etc., to avoid the potential transfer of pathogens to the main areas of the facility.

Facility-specific footwear, or footbaths containing a suitable germicidal solution, should be situated at the entrance to each animal holding area in such a way that they cannot be avoided. Brushes should be made available to remove any organic matter prior to the use of a footbath. Footwear should be cleaned and disinfected (i.e. removal of organic and solid matter from the footwear, followed by the use of a footbath with sufficient contact time between the footwear and solution, with the solution changed regularly, or the use of germicidal sprays).

# 6. HUSBANDRY

The principles described in this section provide ACCs with general guidance which can be used to consider the various types of routine husbandry practice that may be encountered and where the approach may need to be varied depending on the research protocol.

## 6.1 Standard Operating Procedures (SOPs)

A regular, daily routine of management procedures should be established to maintain predictability and minimize stress for the animals.

**Guideline 25:**

**Each facility should have Standard Operating Procedures for routine husbandry and routine invasive practices.**

Each facility should prepare a facility SOP manual for routine husbandry and routine invasive procedures. The manual should be reviewed and updated regularly in light of improvements in animal care practices, and the ACC and the facility management personnel should ensure compliance.

## 6.2 Identification and Record Keeping

A system of permanent identification should be in place for all animals (see Section 10. Species-Specific Considerations for means of identification for various species). Livestock should be identified in accordance with relevant national (http://www.inspection.gc.ca/english/anima/trac/trace.shtml) or provincial livestock identification systems.

Where appropriate, individual records should be kept, indicating such factors as birth date, sex, pedigree, origin, physical measurements, reproduction information, health information, medical history and nutritional history. All animals must be clearly identified (either individually or by group), with the protocol number to which they have been assigned, the name of the principal investigator, emergency contacts, and any other relevant information (including a brief summary of any experimental procedures) on sheets or cards posted on, or near, the enclosures. Records of research activities must also be kept, including a complete record of all experiments, as treatment in one experiment may influence the animals' response in a second experiment.

## 6.3 Housing Management

In general, to improve and enhance the animal's environment, research institutions should address the following:

a) ensure an appropriate level of hygiene for the animals;

b) house compatible animals in groups of appropriate size;

c) provide means for social contact;

d) optimize age of weaning for dam and offspring well-being;

e) provide means for each animal to perform a wide range of normal behaviour, including food searching and foraging;

f) shorten periods of isolation and restraint; and

g) ensure animal comfort in lying and walking areas.

## 6.4 Feed, Water and Bedding

### 6.4.1 Feeding plans

National Research Council (NRC) guidelines or other standard texts should be consulted for recommendations concerning species-specific nutrient requirements. All experimental animals should receive palatable, wholesome and nutritionally adequate feed, according to the requirements of the species, unless the study requires otherwise (see Section 9. Specialized Procedures Used in Research and Testing). All feed should be kept free of contaminants.

Animals should be fed sufficient quantities at appropriate frequencies to minimize hunger and competition for food.

When feed is delivered to animal facilities and to individual feeders, care should be taken to minimize dust.

#### 6.4.1.1 Quality of the feed

The nutrient content of all feed should be verified by laboratory analysis or other tests.

### 6.4.2 Water provision

All animals should have free access to fresh, potable water that is kept free of ice in the winter. Water systems should be tested regularly to ensure that the pressure is sufficiently high to enable animals to drink at a rate appropriate to their needs. Water quality should also be tested regularly and should meet Canadian Environmental Water Quality Guidelines (http://www.ec.gc.ca/ceqg-rcqe/English/ceqg/water/default.cfm).

### 6.4.3 Bedding

The amount and type of bedding used should be suited to the animals being housed, and be compatible with the manure handling system. Bedding should be kept dry and clean.

## 6.5 Environmental Improvement

Animals perform different behaviour patterns in response to a variety and mixture of internal and external stimuli (Hughes & Duncan, 1988). In general, the environment should be designed so that behaviours that are driven only by external stimuli, such as predator-avoidance, do not occur. Thus, if an environment is designed so that predators and predator-like stimuli are never present, then the animal will never be motivated to show this behaviour. In contrast, the environment should be designed to allow the performance of strongly motivated behaviour patterns that are motivated largely by internal stimuli such as changing hormonal levels. When these internal changes take place, the animal will be driven to perform the behaviour in all environments. It is therefore important that the environment provided should allow the animal to perform the behaviour satisfactorily without damaging itself or other animals. Examples include providing an environment that allows for nesting behaviour in domestic fowl (Duncan & Kite, 1989; Hughes et al., 1989) and providing teats for young calves to suck (Rushen & de Passillé, 1995). Improvements such as these should be included in the environment, since some degree of suffering will occur in their absence. Further improvement to the environment is termed *environmental enrichment*. Thus animals would not suffer in the absence of environmental enrichment but would gain some pleasure from its presence (Duncan & Olsson, 2001). Environmental enrichment is encouraged.

## 6.6 Human Contact and Handling

The animal-human relationship is important to animal welfare. Fear is a response to perceived danger. Poor livestock handling techniques and inappropriate attitudes and behaviour in humans may exacerbate fear and increase stress. Stress reduces animal welfare, impacts negatively on performance, and may bias research results.

Positive human contact is important for both animal welfare and productivity. Studies show physiological evidence of long-term stress in animals on farms where the animals react fearfully to people (i.e. shying away or vigorous avoidance) (Hemsworth & Barnett, 1991; Rushen et al., 1999; Breuer et al., 2000). Animals can recognize and remember individual people, and will become frightened of people that have handled them roughly in the past. Animals that are fearful of the people who care for them often show reduced reproductive efficiency (sows) and reduced weight gains (growing pigs). Fear is produced not only by unpleasant handling (goading, slapping), but also by handlers who approach animals too quickly or make too much noise, including shouting. Handlers can reduce fear reactions by moving slowly and calmly, and stroking or scratching animals that approach.

Handling animals effectively and with minimum stress is a skill acquired through training and experience. Animal care staff should receive training in animal behaviour and the proper methods for lifting, moving and herding animals. Knowledge of animals' herding tendencies and flight zones should be used, along with appropriate moving devices (such as chase boards) to move animals calmly. Ears, tails and legs should not be pulled. Electric prods should be severely restricted, and their use only permitted when failing to use them would place the animal under additional stress or risk.

## 6.7 Restraint

Animals should be handled and restrained in facilities and by equipment appropriate for the species and procedure. Restraint devices should not be considered normal methods of housing, although they may be required and approved by the ACC for specific research and teaching objectives.

Some aggressive behaviours of larger farm animals pose risks to the health and well-being of both herdmates and human handlers. These behaviours may be modified or their impact reduced by a number of acceptable restraint devices (e.g., hobbles, squeeze chutes and stanchions). Only the minimum restraint necessary to control the animal and to ensure the safety of attendants should be used.

Animals to be placed in restraint equipment should be conditioned to such equipment prior to initiation of the project, unless the preconditioning itself would increase the stress to the animals. Animals that are subjected to intensive procedures requiring prolonged restraint, frequent sampling or other procedures experience less stress if they are trained to cooperate voluntarily with the procedure. Cattle, pigs, and other animals can be trained with food rewards to accept and cooperate with various procedures.

Attention should be paid to the possible development of lesions or illness associated with restraint, including contusions, knee or hock abrasions, horn damage, ulcers, dependent edema, lameness, joint injury and weight loss. Health care should be provided if these or other serious problems occur and, if necessary, the animal should be removed either temporarily or permanently from the restraint device (FASS, 1999).

Prolonged restraint of any animal must be avoided unless such restraint is essential for the welfare of the animals (e.g., see Section 10.4 regarding farrowing crates for pigs) or for research objectives, in which case scientific justification is required. The period of restraint should be the minimum required to accomplish the research or teaching objectives.

**Guideline 26:**

**Electro-immobilization must not be used.**

Research has shown that electro-immobilization is highly aversive (Grandin *et al*., 1986; Rushen, 1986). During electro-immobilization, animals are effectively paralyzed but remain conscious. There is no evidence that electro-immobilization produces anesthesia or analgesia.

## 6.8 Routine Invasive Agricultural Practices

**Guideline 27:**

**Routine invasive agricultural practices that are likely to cause pain must be described in Standard Operating Procedures that are reviewed and approved by an animal care committee.**

Routine invasive practices have been developed over the years to assist in management of livestock. Some of these procedures can result in temporary or even chronic pain and distress (e.g., dehorning, branding and castration) (Goonewardene & Hand, 1991; Schwartzkopf-Genswein et al., 1998; Bretschneider, 2005; Stafford & Mellor, 2005a). SOPs for these procedures should be in place and reviewed from time to time. Management practices that are likely to cause pain must be reviewed and approved by an ACC. In particular, ACCs should evaluate when the pain of any given procedure is severe enough to warrant intervention (McGlone & Hicks, 1993). ACCs are encouraged to support management practices that minimize the need for invasive procedures, the development of alternative practices, and the use of analgesics as appropriate. Research to improve methods and procedures should be encouraged, and husbandry procedures and practices used by agricultural research facilities should be revised as research demonstrates improved practices. More detailed guidance on common species-specific practices is given in Section 10.

With all species, analgesics should be used in surgical procedures such as dehorning, castration, etc. In addition to analgesics administered prior to the procedure, post-operative pain control should be provided.

Practices that cause pain or distress, or do not satisfy the animals' physical, psychological and social needs and would not normally be accepted by an ACC, cannot be justified by the argument that the practice is common in commercial agriculture. However, commercial agricultural practices might be justified if the experiment requires that particular conditions be replicated for research purposes.

Institutions maintaining livestock for the purposes of research, teaching or testing are in a position to provide leadership in the investigation or trial of alternate practices and the establishment of best practices for the agricultural industry.

## 6.9 Parturition and Care of Young

Parturition is a time when animals are especially vulnerable and need particular attention. See the species-specific information in Section 10.

## 6.10 Health and Disease Control

### 6.10.1 Herd/flock health program

Healthy animals are pre-requisites for reliable data. Farm animals used in science should be free of any disease agents that could lead to a diseased condition (unless it is part of the experimental protocol).

**Guideline 28:**

**All facilities must have a herd/flock health program.**

Institutions housing farm animals for scientific purposes should have access to a veterinarian with expertise in large animal medicine. This individual should assist in the development of SOPs to limit the introduction of disease into the facility, and should be available for consultation on all matters relating to the health of the animals (see Section 2.4.4 Responsibilities of the veterinarian).

**Guideline 29:**

**Strategic measures for disease prevention should include 1) formal written agreement with a veterinarian responsible for the management of the health program; 2) a program for disease control measures, including quarantine, immunization and prophylactic treatments; and 3) a system of regular monitoring and reporting for health assessment purposes.**

Disease prevention measures can impart large advantages in terms of animal welfare, research quality and animal productivity. Each herd / flock should have a disease prevention / herd health plan in place, suited to the health status of the herd, the purposes for which the herd is used, the feasibility of controlling movement of people and animals into the unit, and the vulnerability of the herd to contamination via other disease vectors. The plan should be developed with appropriate veterinary and other expertise, and should include consideration of the following measures:

- assessment of the health status of any animals being purchased or brought into the herd, and isolating and testing such animals;
- where applicable, a breeding plan that provides for healthy replacements (e.g., animal breeding selection indices should consider health performance);
- an SOP for vaccination and parasite control;
- prevention of disease entry via staff, visitors and other users of the facility, including persons transporting animals out of the unit, and especially those who have contact with similar animals on other premises;
- prevention of entry of disease via rodents, birds, insects and wind;
- prevention of transfer of disease when personnel move between different buildings;
- necessary equipment and drugs on hand to treat diseases likely to occur, for immediate care of diseased or disease prone animals;
- monitoring and recording disease incidence, medication use and herd performance, and

implementation of corrective action when evidence of health problems is found; and

- possible consequences of using any drugs or vaccines on subsequent suitability of the animals for scientific use.

Veterinarians should be particularly mindful of the potential risks in transferring infectious organisms.

**Guideline 30:**

**Standard Operating Procedures should be developed for health care and to address common problems for the herd/flock.**

Practices should be developed to minimize persistence of disease organisms in the environment, as appropriate for the health status of the herd or flock. Measures may include emptying, cleaning, resting and disinfecting rooms before a new group of animals is moved in (all-in-all-out).

SOPs should be developed for routine health checks, both for individual animals and for the herd/flock as a whole. In addition, SOPs should be in place for welfare assessment of individual animals.

### 6.10.2 Disease outbreaks

A crisis management program should be in place to deal with disease outbreaks within the facility, as well as outbreaks in nearby facilities. All employees should be familiar with the facility SOPs to deal with reportable and non-reportable diseases.

### 6.10.3 Drug safety

SOPs should be in place for the safe management of all drugs. Drugs and biologicals on-site must be stored appropriately and accessed only by authorized personnel with appropriate training in their use. Good records of drug and biological use must be kept (see *CALAM Standards of Veterinary Care*, 2007, http://www.calam-acmal.org/Content/StandardsVetCare.pdf). Drugs that are past the expiry date, needles and syringes must be disposed of appropriately. SOPs should include management of off-label and extra-label drug use, including reference to the Food Animal Residue Avoidance Databank (FARAD) documentation for safe withdrawal and withholding times (http://www.farad.org).

## 6.11 Disposal of animals

Transportation for slaughter should be in accordance with guidance outlined in Section 5.2 Transportation.

Slaughter of animals (i.e. disposal of animals destined for the food chain) should be done humanely, using approved methods. All killing of food animals must comply with federal legislation (Agriculture Canada's *Meat Inspection Act* R.S., 1985 c.25 [1st Supp.], http://laws.justice.gc.ca/en/M-3.2/82948.html; and the Federal *Health of Animals Act*, 1990 c.21, http://laws.justice.gc.ca/en/showtdm/cs/H-3.3///en). Further slaughter information for each species is provided in the national industry recommended codes of practice for the care and handling of livestock (http://www.nfacc.ca/code.aspx). Provincial legislation on humane slaughter, where it exists, as well as municipal and local by-laws, must also be followed.

Food animals treated with new drugs or experimental vaccines, or challenged with pathogenic organisms, are not normally acceptable for slaughter for food or rendering for feed. This includes the release of treated animals for growth and fattening for eventual slaughter, and also includes the release of milk, eggs and other products from treated animals. Apart from concern of the contamination of food and animals with pathogens, is the concern that media used for growing pathogens or experimental vaccines is often not certified free of Transmissible Spongiform Encephalopathies (TSEs). The disposal of food animals from facilities should include a sign-off process under the authority of the principal investigator to ensure the selection of an appropriate and legal route of disposal. Investigators requesting permission to dispose of animals or products from animals involved in experimental vaccine trials into the food chain should contact the Veterinary Biologics Section of the CFIA (http://www.inspection.gc.ca/english/anima/vetbio/vbpbve.shtml). Researchers intending to use a new drug in food animals should contact the Veterinary Drugs Directorate of Health Canada for an Emergency Drug Release (http://www.hc-sc.gc.ca/dhp-mps/vet/edr-dmu/index-eng.php) or for an Experimental Studies Certificate (http://www.hc-sc.gc.ca/dhp-mps/vet/applic-demande/form/esc-cee_08-2002_cp-pc-eng.php). SOPs must be in place to ensure that drug-contaminated carcasses do not enter the food chain via rendering. This may require provision of incineration/cremation.

Where radioisotopes have been used for research protocols, animals must not enter the food or feed chain. Acceptable storage and disposal procedures for these carcasses must be in place.

Euthanasia of animals not entering the food chain must be in accordance with *CCAC guidelines on: laboratory animal procedures – adopted guidelines on euthanasia* (in prep.). Table 1 provides a summary of the recommended methods of euthanasia for farm animals. More detailed information on these methods is provided in the species-specific subsections of Section 10.

## Table 1 Methods of Euthanasia

| **Species** | | **Recommended methods of euthanasia** |
|---|---|---|
| CATTLE | | Anesthetic overdose |
| | | Penetrating captive bolt, followed by bleed out |
| | | Gunshot in exceptional circumstances |
| SHEEP & GOATS | | Anesthetic overdose |
| | | Penetrating captive bolt |
| | | Gunshot |
| PIGS[a] | piglet <3 weeks (5.5 kg or 12 lbs) | Anesthetic overdose |
| | | Blunt trauma[b] |
| | | $CO_2$ |
| | Nursery pig < 10 weeks (32kg or 70 lbs) | Anesthetic overdose |
| | | Penetrating captive bolt |
| | | $CO_2$ |
| | Grower pig (< 68 kg or 150 lbs)<br>Finisher pig (>68 kg or 150 lbs)<br>Mature animal (sows or boars) | Anesthetic overdose |
| | | Penetrating captive bolt |
| POULTRY | | Anesthetic overdose |
| | | Cervical dislocation (for small numbers of birds) |
| | | $CO_2$, particularly for large numbers of birds |
| | | High speed maceration |

[a] Adapted from *On Farm Euthanasia of Swine – Options for the Producer* (National Pork Board, 2008)

[b] Blunt trauma is defined as a quiet, firm and accurate blow to the top of the head over the brain, with sufficient force to euthanize rather than stun the animal (National Pork Board, 2008)

SOPs must be in place for emergency disposal of animals. These should include on-farm euthanasia for animals that cannot be moved to slaughter facilities, and emergency killing for disease control. Preparation of SOPs for emergency disease outbreak provides an opportunity to evaluate potential methods of euthanasia to minimize both potential pain and distress for the animals, minimize disease spread, and take into consideration the concerns of individuals who may be required to carry out the procedures.

## 6.12 Staff and Training

**Guideline 31:**

**All staff must be appropriately trained and competent with the husbandry skills required to ensure the health and welfare of animals in their care.**

Animal husbandry is the science and art of breeding, raising and managing livestock. Good husbandry practices are heavily reliant on good personnel. Experience has shown that in general good stock people share the following characteristics:

- like animals;
- understand animals' needs;
- recognize the importance of the well-being of animals;
- are trained in humane livestock handling;
- work among animals in a consistent manner;
- are knowledgeable about the interdependence of animals and people;
- have experience with the species and the operation of the unit;
- maintain a positive attitude; and
- exhibit patience and a calm approach.

# 7. HUMAN SAFETY

The institution is responsible for ensuring appropriate training of staff for facility maintenance and animal care tasks, as required by their positions, and ensuring staff are aware of the associated risks and how to minimize them. The investigator is responsible for ensuring that any personnel involved in the research project are adequately trained and informed of any additional risks inherent in the research project, and for ensuring that emergency procedures appropriate for the intended study are in place.

Personnel who will be at risk of health and safety hazards should be provided with clearly defined procedures for conducting their duties, should understand the hazards involved, and should be proficient in implementing the required safeguards. Investigators are responsible for ensuring that staff members involved in their project are competent to work under the conditions required.

Staff who oversee research programs that involve hazardous biological, chemical or physical agents, or who will come into contact with these agents, should be qualified to assess dangers associated with the work and to select safeguards appropriate to the risks. This should involve consultation with the relevant institutional safety officers.

Staff members who may come in contact with animals should receive appropriate vaccinations, including tetanus.

Animal care personnel should be trained in the following areas:

- zoonotic risks;
- chemical safety;
- microbiological and physical hazards;
- unusual conditions or agents that might be part of experimental procedures (including the use of genetically-engineered animals and the use of human tissue in immunocompromised animals);
- handling of waste materials;
- personal hygiene; and
- other considerations (e.g., precautions to be taken during personnel pregnancy, illness or decreased immunocompetence) as appropriate to the risk imposed by the workplace.

## 7.1 Biohazards

The investigator is responsible for identification of any specific biohazards or zoonotic agents that may reasonably be expected to be encountered. Staff must be informed about the possible routes of disease transmission and exposure, and trained in the use of protective equipment, medical interventions and safety procedures that are to be used to manage the hazard.

During review of the animal use protocol, the ACC should ensure, through communication with the in-house biosafety committee or through consultation with an outside expert, that any potential biohazards have been properly identified.

All accidents or suspected exposures to infectious biological agents must be reported immediately to the nearest medical authorities as described in the emergency plan. The investigator must be notified and a record of the accident or injury kept. Any unexpected illness must also be reported immediately in a similar manner.

## 7.2 Occupational Health and Safety

An effective occupational health and safety (OH&S) program ensures that the risks associated with the use of animals are reduced to acceptable levels.

Investigators are responsible for their own health and safety as well as that of their co-workers. Investigators must ensure that the hazards to human health and safety when working with animals are clearly identified and communicated to the project personnel, and that training, written procedures and any necessary protective clothing and equipment are provided to ensure that personnel are protected against possible injury or exposure to potentially dangerous animals or their fluids or waste. The ACC must ensure that chemical and other hazards are properly identified, and that the biosafety officer and biosafety committee have been informed of the work.

Investigators should maintain a record of any injuries incurred while handling farm animals. Applicable local regulations regarding the documentation and reporting of workplace injuries should be consulted.

A record must be kept of all training in OH&S given to staff, with the date of the training and signature of the staff member.

## 7.3 On-farm Safety

Farm animal facilities used for research, teaching and testing must be a safe workplace. The fifth highest cause of on-farm fatalities in Canada over the last decade was related to working with animals (Canadian Agricultural Injuries Surveillance Program, http://meds.queensu.ca/~emresrch/caisp/). Of those animal-related fatalities, most occurred during "herding" and "feeding/watering", followed by "inspecting and veterinary procedures". These are activities typical of the research and teaching use of farm animals. Therefore, investigators and supervisory personnel must identify any foreseeable hazards that can arise and that have the potential to harm the health and safety of co-workers on the farm. Moreover, effective procedures must be put in place and implemented to assess and control those hazards and risks, including SOPs and training. In particular, proper methods of restraint must be used to minimize injury.

Investigators and other staff are encouraged to familiarize themselves with on-farm safety manuals, e.g., *Protect Yourself from Livestock Injuries* (Nova Scotia Department of Agriculture, 2004, http://www.gov.ns.ca/agri/farmsafety/livestock/index.shtml).

# 8. TEACHING

An important role of some colleges and universities is teaching students how to work with farm animals. Teaching institutions are expected to play a leadership role in the demonstration and implementation of best practices. Use of live animals to teach a skill must always be approached seriously.

## 8.1 Supervision

**Guideline 32:**

**Untrained students must be instructed by a trained instructor who must supervise all aspects of their performance until they are deemed competent.**

Instructors must be well versed in the techniques they teach, keeping in mind that the techniques learned by students are those which will be carried into their own careers. Supervisory personnel must know how to instruct students in the correct techniques, and how to correct errors. They must be ready and willing to stop a procedure if animal distress becomes obvious or excessive.

### 8.1.1 Demonstration versus building competence

The instructor must decide whether the purpose of an exercise is to demonstrate its performance or to teach competence in the performance of the procedure. For the former, consideration should be given to using a video, physical model or computer model to demonstrate a technique. If the purpose is to make students competent in a certain skill, then the use of live animals is warranted, but the cost and benefit must be weighed. Instructors should reflect on whether it is really necessary to teach competence, and the amount of distress the animal will experience if competence is to be achieved.

### 8.1.2 Rehearsing

Preparatory sessions, or *pre-labs*, can be used to help students perform an exercise effectively. Before working with live animals, students must clearly understand the procedure they are about to do, why they are performing a particular procedure, and potential problems associated with the procedure. Visualizing a procedure has been shown to help learning, and students being taught skills should rehearse their task by describing in detail what they are about to do. In this context, well-written SOPs are invaluable. Commercially available models may be available to help prepare for some procedures (e.g., for lambing and rectal examinations). If available, necropsy specimens can be used to refine palpation techniques (e.g., for assessing estrous cycles in cows).

### 8.1.3 Painful Procedures

Some potentially painful procedures are commonly used in Canadian agriculture. These include castration, tail docking, horn de-budding, tooth clipping and beak trimming. There is an ethical dilemma associated with teaching students how to perform painful procedures. While it is essential that such techniques are taught properly at agriculture and veterinary schools, an appreciation of pain experienced by animals should be emphasized in teaching (McGlone & Hicks, 1993), as well as the importance of considering species-appropriate analgesia/sedation or anesthesia.

## 8.2 Frequency-of-Use

**Guideline 33:**

**When planning student exercises with animals, the instructor must carefully weigh the pedagogical merit of the procedure against the invasiveness of the procedure and how often it will be carried out on each animal.**

Even relatively innocuous procedures, when done repeatedly, can be harmful to animals. Special precautions need to be taken when potentially painful or distressing procedures (e.g., rectal palpation, tail or jugular bleeding, etc.) are taught. Endpoints need to be set in advance by the course instructor and approved by the ACC. Records that document animal use under approved conditions should be kept to prevent an excess of manipulations, especially of those animals that, by their natures, may be more disturbed by such repeated manipulations. As far as possible, student practical sessions should be timed to coincide with routine husbandry (e.g., worming, metabolic profiles, etc.).

The local ACC must be presented with sound reasons for any given student-animal ratio. Student-animal ratios and instructor-student ratios must be such that there is adequate supervision and monitoring of student performance and of animal use and discomfort levels.

### 8.2.1 Alternatives and ethics

In all cases, consideration must be given to alternative approaches which do not involve the use of live animals. Students should receive instruction on the ethics of animal research and other animal use prior to undertaking any instructional exercises. The instructor must be sensitive to differences among the students in their values and their tolerances to the animal procedure being done.

Animals should not be maintained indefinitely for teaching purposes. There should be an established length of time and/or number of training procedures that an animal is involved in before disposition of the animal and replacement. This will include consideration of a number of factors, including the level of invasiveness of the procedure and whether the animal is used for other purposes.

# 9. SPECIALIZED PROCEDURES USED IN RESEARCH AND TESTING

## 9.1 Special Considerations for Care of Animals

Animals that are used in specialized procedures require additional care, and sometimes particular environments. Personnel responsible for caring for these animals require special training to be able to care for the animals and to ensure early identification of any problems. SOPs should be in place to detail the requirements for the animal, including post-operative care.

Veterinarians responsible for the health of the animals must be made aware of the procedures that have been carried out on the animals, if they have not been directly involved, so that they can intervene if a problem is identified.

## 9.2 Metabolism Studies

Guideline 34:

**Metabolism crates must only be used for approved short-term studies, not for routine housing.**

Many studies of the nutrition and physiology of agricultural animals use a specialized piece of equipment, the metabolism crate. These crates are used to restrict an animal's movement sufficiently to allow the collection of urine, feces and respiratory gases, or to protect catheters or cannulae. The degree of restraint of animals housed in metabolism crates is substantially different from that of other methods that restrict mobility (e.g., stanchions and tethering). Animals in metabolism crates may be held by a headgate or neck tether, and are restricted in their lateral and longitudinal mobility. These differences may exacerbate the effects of restriction on animals housed in metabolism crates. Investigators should consider appropriate alternatives to metabolism crates if such alternatives are available.

Reactions of animals to close confinement may be extreme, especially if combined with food restriction (Appleby, 1995). Therefore, investigators should consider preconditioning animals to the crate by gradually introducing them to it for increasing times over at least 5 days, and pairing this with some type of reward (as long as this does not interfere with the experimental protocol). This is particularly important for animals that have previously been group housed. Consideration should also be given to the species and breed used, as some animals are better able to adapt to close confinement. The aim is to ensure adequate adjustment and comfort of the animal before sample collection starts. The length of time for the preconditioning period should be subject to approval of the ACC. When possible, metabolism crates should be positioned so that the animal is in visual, auditory and olfactory contact with conspecific animals to minimize the effects of social isolation.

Similar practices should be followed for other types of restraint that may be necessary for the purposes of a research study.

Guideline 35:

**Metabolism crates must have enough room for animals to adopt comfortable resting positions, and must be well maintained to prevent injury.**

Metabolism crates should provide sufficient space for the animal to rise and lie down normally. Comfortable posture depends upon, among other things, the effective environmental temperature (animals use body posture, stretching out or huddling to thermoregulate), sufficient height to accommodate standing, and space to the feeder.

Thermal requirements of animals may be affected when they are placed in metabolism crates. For example, the lower critical environmental temperature of an animal held individually in a metabolism crate is higher than when residing in a group because the single animal cannot obtain the heat-conserving benefits of huddling with group mates, and bedding is not available in metabolism crates.

Animal care staff should be trained to identify signs of distress.

**Guideline 36:**

**Animals should not be held in metabolism crates for longer than seven days without at least a 24 hour period of turn out (opportunity for exercise), and no more than two months in total.**

Animals in metabolism crates should be observed more frequently than those in other environments, and particular attention should be paid to changes in behaviour and appetite and the condition of the skin, feet and legs. The length of time an animal may remain in a metabolism crate before removal for exercise should be based on professional judgment and experience, scientific justification and assurance of appropriate welfare safeguards, and be subject to approval by the local ACC. The species and the degree of restraint imposed by particular crate types should be taken into consideration in making such judgments (FASS, 1999).

If metabolism crates are used, provision of adjacent space for exercise may be required.

Crates should be sanitized on a weekly basis, which will likely coincide with the exercise period.

## 9.3 Blood, Body Fluids and Tissue Sampling

Animals react to human contact behaviourally and physiologically in ways that may interfere with the topic under study, and as far as possible, remote sampling should be used. Animals should be trained to enter restraining devices and should be accustomed to the procedure prior to sampling.

Sampling of blood and tissue, including tooth extraction, should be performed only after appropriate training and adequate experience. Procedures and protocols must be chosen that avoid or minimize pain and distress. The use of more easily acquired fluids such as saliva, milk, etc. should be considered as possible alternatives to blood collection in some cases.

Blood removal is one of the most common procedures performed on animals in research. The advice of a veterinarian can be helpful in deciding on, and training in, proper blood and tissue sampling methods. The need for an anesthetic depends upon the restraining method, the physical condition of the individual animal, and the tissue and/or volume of blood required. As a general rule, the volume of blood collected should be no more than 10% of the total blood volume of the animal (see Section 9.3.1 Blood volumes). Recommended methods of blood sampling are provided in Table 2.

Where multiple blood samples need to be taken, cannulation of the animal should be considered. The smallest diameter of cannulae that works effectively should be used to minimize discomfort for the animal. Cannulae should be flushed

### Table 2 Recommended methods of blood sampling

| | |
|---|---|
| Poultry | • brachial vein (see http://ohioline.osu.edu/vme-fact/0023.html)<br>• cardiac puncture can be used as a terminal procedure |
| Pigs | • ear vein, tail vein or major vessels of the thoracic inlet (includes external jugular vein and exterior vena cava) (see http://oslovet.veths.no/teaching/pig/pigbleed/)<br>• sampling should be done on right side since the phrenic nerve lies next to the left external jugular |
| Piglets | • external jugular vein, cranial vena cava or perineal vein |
| Sheep | • jugular vein |
| Cattle | • tail vein<br>• if more volume is required: jugular vein |
| Calves | • jugular vein or tail vein |

regularly with sterile anticoagulant solution to maintain patency.

Temporary cannulae should always be removed promptly at the end of the sampling period to reduce the possibility of infection. Following cannulation, strict attention must be paid to the different symptoms of contamination, including septicemia (e.g., elevation of body temperature and reduction in food intake).

Information on safe bleeding volumes is given in Section 9.3.1; however, the amount of blood taken should be limited to the actual needs, rather than the maximum amount that can be safely taken, to reduce stress on the animal. The actual need should also take into account plans to resample later. When carrying out multiple sampling, haematocrit should be checked to ensure that the animal does not become anaemic.

### 9.3.1 Blood volumes

The following calculations for safe bleeding volumes for farm animals are based on *Lab Animal Formulary*, 3rd ed. (Hawk et al., 2005).

#### 9.3.1.1 Single sample

To calculate the maximum single blood volume sample for an animal

1. locate the one bleed maximum (ml/kg) for the species to be sampled from Table 3;

2. weigh the animal to be sampled (kg); and

3. multiply the one bleed maximum (ml/kg) by the animal's weight (kg).

For example, the maximum single blood sample to be taken from a 30 kg pig would be 6.6 ml/kg x 30 kg = 198 ml.

#### 9.3.1.2 Multiple samples

To calculate the multiple sample safe bleeding volume

1. locate the mean blood volume (ml/kg) for the species to be sampled from Table 4;

2. weigh the animal to be sampled (kg);

3. multiply the mean blood volume (ml/kg) by the animal's weight (kg) to get the animal's total blood volume in ml; and

4. multiply the animal's total blood volume by the % from Table 5 (based on the frequency of resampling).

For example, the maximum amount of blood that can be taken per sample for a 30 kg pig, where weekly blood samples are to be taken for 4 weeks, is calculated as follows:

65 ml/kg x 30 kg = 1950 ml total blood volume; and

1950 ml total blood volume x 7.5% = 146.25 ml per sample.

**Table 3 Maximum single blood volume samples**

| Species | One bleeding (maximum) ml/kg |
|---|---|
| Cattle | 7.7 |
| Goat | 6.6 |
| Sheep | 6.6 |
| Pig | 6.6 |
| Chicken | 9.9 |

Adapted from Mitruka & Rawnsley (1977)

**Table 4 Mean blood volume per species**

| Species | Blood volume mean (range) ml/kg |
|---|---|
| Cattle | 57 (52-61) |
| Goat | 70 (57-89) |
| Sheep | 66 (60-74) |
| Pig | 65 (61-68) |
| Chicken | 60 |

Adapted from Altman & Dittmer (1974) and Morton et al. (1993)

**Table 5 Percent blood volume removed per sampling period**

| Recovery time before next sampling (weeks) | Blood amount removed (% of body weight) |
|---|---|
| 1 | 7.5% |
| 2 | 10% |
| 4 | 15% |

Adapted from Diehl et al. (2001)

## 9.4 Surgical Procedures

**Guideline 37:**

**Surgical procedures must only be performed by well-trained, competent individuals.**

The competency of an individual to perform invasive techniques should be evaluated prior to conduct of the procedure. Development of the necessary skills to perform a procedure competently may involve training by observation and use of inanimate models, followed by close supervision when the individual is permitted to carry out the procedure in vivo. In all procedures involving a live animal, the well-being of the animal should be of primary concern.

Animals that undergo major surgery require considerable care. Appropriate peri-operative and intra-operative support must be provided. Personnel responsible for caring for these animals require special training to be able to care for the animals and to ensure early identification of any problems.

Major surgeries are those that penetrate and expose a body cavity or produce substantial impairment of physical or physiologic function. Major survival surgeries must be performed in facilities designed and prepared to accommodate surgery and standard aseptic surgical procedures. Good surgical practice includes the use of surgical caps, masks, gowns, sterile gloves and sterile instruments, as well as appropriate site preparations and draping. For short (<30 minutes) non-survival surgeries during which the animal is euthanized before recovery from anesthesia, it may not be necessary to follow all of these techniques, but the instruments and surrounding area should be clean. For longer non-survival surgeries, good surgical practice is necessary to prevent septic effects on research results.

Minor surgical procedures that do not penetrate a body cavity or produce substantial impairment (e.g., wound suturing and peripheral vessel cannulation) may be performed under less stringent conditions if performed in accordance with standard veterinary practices (Brown et al., 1993).

Therapeutic and emergency surgeries (e.g., caesarian sections, bloat treatment and repair of displaced abomasum) are sometimes necessary in agricultural situations that are not conducive to rigid asepsis. However, every effort should be made to conduct minor and emergency surgeries in a sanitary and aseptic manner, and appropriate anesthetics, analgesics and sedatives should be used commensurate with risks to the animal's well-being. Research and teaching protocols that carry a high likelihood of the need for emergency surgery must contain provisions for handling anticipated cases. Surgical packs and equipment for such events should be prepared and be readily available for emergency use (FASS, 1999).

Animals must be monitored post-surgery for signs of discomfort, distress and pain. Adequate pain relief must be provided in a timely manner.

Pain management in farm animals involves special considerations. For ruminants, there are a number of licensed non-steroidal anti-inflammatory drugs (NSAIDs) available that can control post-operative pain, but narcotics produce some undesirable side effects. Local anesthetics (local nerve blocks) are useful in farm animal species, but the effects are short-lasting and they do not provide relief of post-operative pain. A veterinarian should be consulted for all use of pain medication.

## 9.5 Fistulation/Catheterization

Harmon & Richards (1997) provide guidance in the use of gastrointestinal fistulation in ruminants. They compare the advantages and disadvantages of various approaches, catheter types and catheter materials that should be considered before experiments are conducted. Proper equipment should be used to restrain the animals during catheterization, and proper procedures should be employed during sampling, to prevent injury to personnel and animals.

Animals that have indwelling catheters require additional care, and sometimes particular environments. Personnel responsible for caring for these animals require special training to be able to care for the animals and ensure early identification of any problems. SOPs must be in place to detail the requirements for post-operative care of a catheterized animal, including the care and maintenance of the catheter itself.

In some instances, implanted telemetry devices may be used to monitor an animal remotely. These animals should be clearly identified in order to monitor any adverse effects following surgical implantation of the device or any subsequent long-term effects as a result of the device.

Protocols including the use of catheters should have defined endpoints, both for complications and for removal of the catheter.

## 9.6 Endpoints

**Guideline 38:**

**The earliest endpoint that is compatible with the scientific objectives of the approved protocol should be used.**

In experiments involving animals, any actual or potential pain, distress or discomfort should be minimized or alleviated by choosing the earliest endpoint that is compatible with the scientific objectives of the approved protocol. Selection of this endpoint by the investigator should involve consultation with the attending veterinarian and the ACC.

There are several considerations in defining an appropriate endpoint in a given experiment. These depend on objective determinations of what constitutes deviation from an animal's *normal* state. Some of these considerations include

- making the appropriate observations of the animals (behaviour, physiology, etc.);
- assigning objective values to the observations of animal behaviour and physiology;
- determining which observations are the most significant indicators of pain and/or distress in the specific circumstances of the research;
- determining which observations are the most significant predictors of further deterioration in the animal's condition, and then identifying the earliest point at which those signs appear;
- meeting the scientific demands for an objectively measured and significant endpoint;
- clearly defining the information/data being sought in the experiments; and
- clearly defining potential complications and planned actions to deal with such complications, including termination of the experiment.

All investigators conducting experiments with farm animals must be familiar with the *CCAC guidelines on: choosing an appropriate endpoint in experiments using animals for research, teaching and testing* (CCAC, 1998), where more detailed information can be found.

## 9.7 Farm Animals Used in Biomedical Science/Research

Farm animals are used not only to address basic and applied science questions in agriculture, animal science and veterinary medicine, but also to address questions concerning human health. The selection of a farm animal as a biomedical experimental subject creates a number of challenges which must be addressed if the work is to be humane as well as scientifically meaningful. The best agricultural practices outlined in the preceding sections may be inadequate to reconcile animal needs and experimental constraints. The guidelines that follow are intended to assist decision making in the selection and use of animals for biomedical purposes. They are founded on the CCAC's ethical imperative of the "right animal for the right reason" (Rowsell, 1984), and are based on practical experience and science-based evidence.

### 9.7.1 General considerations

Investigators, veterinarians and animal care personnel should use relevant, guidelines or other animal welfare science-based evidence to balance the scientific goals of a study with the particular needs of the farm animal of choice.

### 9.7.2 Selection of appropriate animal model

Some factors which must be taken into consideration in selecting the appropriate animal model include the following from Martin & Bateson (1986):

- the sentience of the animal;
- the availability of the animal in captive conditions;
- the animal's tolerance of humans;
- special housing and husbandry requirements;
- the lifespan of the animal;
- the availability of information on the anatomy, physiology and behaviour of the species; and
- the suitability of the animal's physiology and/or behaviour to the problem to be studied and the experimental conditions.

In biomedical research, the scientific performance demands placed on the research animal may have no relation to its agricultural utility. For example, dairy cattle bred for milk production may be used for medical devices research. In these cases, the attributes that make an animal agriculturally useful may be experimental hindrances or variables that must be managed or overcome. Therefore, a flexible, innovative, case-by-case approach is needed for the management of farm animals in biomedical research.

**Guideline 39:**

**The duration of the study should be considered in relation to the growth and life stage of the animal.**

Some farm animal species are established standard models for biomedical research in particular subject areas, and their selection is preferred in most instances. Examples include pigs for skin grafting and reconstructive surgery; pigs for cardiac research; calves for ventricular assist device development; and sheep for perinatal research.

In providing models for adult humans, physiological, biochemical or anatomical criteria often dictate the use of farm animals of comparable size and/or physiological performance. The relative maturation of the selected animal model must also be considered in order to address any potential discordance between size, physiological and biochemical performance (e.g., cardiac output) and age or physiological maturity. For example, long-term studies may be precluded because animals may quickly exceed the physiological performance, size or weight requirements of the experiment. Moreover, they may also exceed the size and weight that can be safely handled in the biomedical research facility. Secondary sex characteristics may come into play that may not be desirable experimentally, and may create an operator or animal health risk. In the case of medical devices, research animals may outgrow the device (e.g., heart valves or orthopaedic devices) with adverse consequences. Sometimes, these constraints can be overcome by selecting an alternative farm animal, for example use of an adult goat or sheep may be an appropriate substitute for a pig or calf.

Conversely, the use of immature farm animals is useful in paediatric research to study outcomes in relation to growth. Since the time course to adulthood for some farm animal species is short compared to humans, these questions can often be answered in a timeframe suited to the research design.

**Guideline 40:**

**Careful consideration should be given to experimental design, in particular to address the genetic variability of farm animal species.**

Investigators and ACC members should be aware that there is considerably more genetic variation in livestock than in traditional rodent models (Festing et al., 2002). This will increase the variability in response to any treatment, and therefore an increased number of animals may be required to detect differences among treatments.

In the development of a novel farm animal model, the life history of the proposed animal must be taken into account to determine its appropriateness. Genetic homogeneity or other genetic variability may also need to be evaluated. In some instances, species may be available which are sound choices scientifically but may not be suitable in respect to constraints of age, physiology, anatomy, biochemistry, size, behaviour and genetic homogeneity or other genetic variability.

### 9.7.3 Acquisition

Due to the specialized nature of some animals used for biomedical research purposes, the following considerations may be necessary, in addition to the requirements provided in Section 5. Acquisition, Transportation and Quarantine.

The acquisition and maintenance of some farm animal species may be subject to governmental regulation. Regulation may include restrictions on importation or exportation into/out of Canada, quarantine restrictions, and restrictions on the movement of animals between facilities within Canada. If suppliers are out-of-country, sufficient lead time should be provided between placement of the request to obtain an animal and the start date of the experiment, to ensure sufficient time to meet all regulatory requirements.

Farm animal research subjects should be obtained from reputable suppliers. Disease-free animals are preferred, unless a disease is the object of scientific interest. Primary agricultural producers are usually willing to provide animals of the required specifications (including, handling and training to lead, castration, late weaning, etc.). Relationships should be cultivated with suppliers as being in the best interests of all parties, including the animals.

The transportation of farm animal species to enclosed city-based facilities presents unique challenges. Vehicles must be suitable for the species and the time of year, and should facilitate the unloading of animals. Matters of security and public relations should be taken into consideration when planning transportation.

### 9.7.4 Meeting the social and behavioural needs of the animals in a confined environment

Basic information concerning the social and behavioural needs of the various species can be found in the species-specific sections of this document (Section 10.), and should be consulted in addition to the following recommendations.

**Guideline 41:**

**The experimental design should address the behavioural needs of the research animals and ensure that these can be normally and safely expressed.**

To meet the needs of the animals, it is important to have comprehensive knowledge about their behavioural needs. These needs may have an impact on the suitability of the farm animal model for the intended experimental purpose, and therefore must be taken into consideration when planning a research study. Such consideration will extend not only to behaviours *per se*, but also to the infrastructure in place to support the animals (e.g., specialized housing, feedstuff and equipment). For example, grazing animals, if they cannot be allowed to graze, should be given access to feedstuffs that will permit the grazing behaviour to be expressed.

**Guideline 42:**

**Farm animals that prefer to live in flocks or herds should be housed in groups, where possible. If singly housed, they should be in a room with other socially compatible animals.**

**Guideline 43:**

**When housing constraints are imposed, their effects should be taken into account in interpreting animal behaviour and experimental data.**

Animals that are normally housed with other animals should be group or pair-housed, or at least housed within the sight and sound of other animals of the same species, even if this requires adding a non-experimental animal to the unit. For species that live in herds or flocks, an experimental requirement to isolate and individually house an animal for the duration of a long-term study may be detrimental to the animal's well-being.

**Guideline 44:**

**Animals subjected to close confinement should be provided with the opportunity for regular exercise at least every 7 days.**

Where animals are expected to be maintained for long periods of time, exercise can be beneficial to maintaining the health of the animal, although traditional approaches to exercise may be precluded. In such instances, alternate approaches may be necessary, for example treadmill exercise.

**Guideline 45:**

**Where there is a requirement for sustained human-animal interaction, animals should be habituated to handling.**

### 9.7.5 Facilities

Biomedical research facilities that are to house farm animal species must be properly designed to provide safe and comfortable quarters for the animals. Appropriate husbandry, sanitation and hygiene programs must be developed which address animal health concerns and infection control, including zoonoses, and satisfy the requirements of occupational health and safety programs. Equipment used to contain, transport or restrain farm animals must be appropriate for the species and the intended purpose, and be readily sanitizable. Medical and experimental management of research animals must be performed according to acceptable veterinary practices (CALAM, 2007). Necropsy facilities must be properly equipped to address zoosanitary concerns, limit operator exposure to biological materials, and allow for the safe handling of the carcasses.

Infection control protocols which address zoonoses must be established in accordance with the identified risks and vulnerability of the populations at risk (e.g., other animals, animal care givers, researchers and patient populations in hospital-based research institutes/medical schools). Particular measures should be taken for farm animal species known to be cross-over agents or reservoirs for particular infectious disease organisms, especially if that farm animal carries human genes (for example swine and influenza). Farm animal waste, including tissues and carcasses, must be managed in accordance with zoosanitary practices and governmental regulations, including regulations relating to occupational health and safety.

### 9.7.6 Medical devices research

**Guideline 46:**

**In vivo medical devices research must take into account the effect of the device, device deployment systems, device-patient interfaces and performance instrumentation in relation to animal well-being.**

Medical devices come in many forms, sizes and complexities. Each device, as well as its delivery system(s), proposed device-patient interface and performance instrumentation, whether clinical or experimental, will have design and performance specifications. This information is important for assessing the prospects for successful and humane use.

**Guideline 47:**

**The implications of device failure must be considered in relation to the animal and the operators.**

Device performance reliability, material bio-compatibility and repair strategies factor into the development of the experimental protocol and animal model. If the purpose of a device is to support or overcome a pre-existing pathologic condition (e.g., a bone fracture), the animal model must be capable of properly reproducing the pathology the device is designed to remedy. Humane endpoints must be established which expressly address the balance between the science and the welfare of the research animal, and provide instructions on actions to be taken in the event of device failure or malfunction. These endpoints must be agreed as part of the protocol review by the ACC. The protocol must also take into account the impact of device failure on personnel who may be attending to the animal so as to avoid injury to operators (e.g., heart failure may result in an animal collapsing on a handler, or a device failure may result in a seizure causing the animal to kick).

Device or component replacement and in vivo repair may be appropriate in some instances, for example the replacement of a screw on an orthopaedic dynamic compression plate. However, there are instances where repair or replacement would not be in line with the principle of humane endpoints, for example repair or replacement which involves major second survival surgery. In such instances, the animal should be euthanized.

Prior to in vivo experimentation, medical devices should be fully tested in the in vitro setting. This testing can take many forms, based on the particular device and its components; the intended mechanical operation; the integrated circuitry; batteries; the intended device output(s); the biomaterials; and proposed clinical and experimental device-patient interfaces. This list is not exhaustive, but serves to signal some of the issues that should be addressed in the laboratory setting prior to use in an animal. The designing of devices and/or their components is always done in the context of intended use and target species. Therefore, the use of non-survival anaesthetized, pain-medicated animals may be appropriate during the design refinement stage.

Medical devices may be internal (e.g., vascular stent) or external (e.g., intravenous pump). In the case of internal devices, strategies for long-term and short-term assessment of the animals should be developed based on the species and the invasiveness of the device.

## 9.8 Genetically-engineered farm animals

### 9.8.1 Definitions

Genetically-engineered farm animals are animals that have one or several genes inserted, deleted or silenced by methods of biotechnology. The affected genes may be naturally found in the animal's genome, or may arise from a different strain or species. Genetic modification involving the addition of genes from one species in the genome of another species or the removal of genes is commonly referred to as transgenesis (Robl et al., 2007). Traditional methods of genetic selection through breeding are not included in this definition.

Cloned animals are also derived from biotechnological interventions. Cloning, or nuclear transfer, is used to obtain a replica of an animal, whether genetically-engineered or not. Cloning is a term used to describe different reproductive techniques that make duplicates of an organism, for example, clones equivalent to identical twins could be produced by embryo splitting. Cloning by nuclear transfer is unique in that it could use an embryonic or adult cell as the source of a nucleus (Vajta & Gjerris, 2006). The advantage of the nuclear transfer technique over the previous cloning techniques is that it allows the production of several nearly identical genetic copies of a selected animal exhibiting characteristics of interest (i.e. the donor animal). Cloning may also have animal health and welfare implications.

Because of the complexity associated with the expression of an animal's genome, these guidelines are intentionally broad; they cannot address every new physiological characteristic associated with the new traits and their potential differential management requirements. For additional guidance, the *CCAC guidelines on: genetically-engineered animals* (in prep.) should be consulted.

### 9.8.2 Cloning

Cloning techniques are likely to be used for livestock as a means to perpetuate or disseminate *elite* genes. Clones can be used to identify genotype versus environmental interaction more accurately for any production trait. They can be used to preserve valuable genotypes. In combination with genetic modification, cloning techniques can be employed to create new genotypes with improved production characteristics. Cloning may also be used in connection with transgenesis; in vitro modified stem cells could be used as the source of nuclei for clones, or existing genetically-engineered animals could be propagated by cloning. In both instances, complications arising from cloning and genetic modification could play a role in the resulting animal's welfare (Wells, 2005).

The following factors may compromise the well-being of cloned animals and should be taken into consideration when evaluating protocols involving cloning. Where new techniques have evolved to address these concerns, they should be used.

- Little is known about nuclear reprogramming and how cytoplasmic factors are able to redirect the fate of the diploid nucleus. The aberrant development of some cloned fetuses and high mortality rates in cloned offspring may be associated with incomplete nuclear reprogramming (Beyhan et al., 2007).

- It is currently not known whether germline modification of DNA, particularly of imprinted genes, is important for normal development of cloned embryos/fetuses. DNA of cloned embryos may lack imprinting patterns that are important for normal development. It is not known whether compensatory mechanisms exist in the reconstructed embryo (Swales & Spears, 2005).

- The stage of somatic cell cycle at the time of nuclear transfer may be important. The reprogramming of a G1 nucleus (immediately after mitosis) may be more effective than a G0 (senescent) or G2 (immediately before mitosis).

- The role of mitochondrial DNA (non-genomic DNA) in determining the outcome of nuclear transfer may be important (Hiendleder, 2007). Qualitative genetic selection of livestock (i.e. selection on traits determined by genomic DNA) may influence mitochondrial DNA, and if so, this may be important in determining the fate of the reconstructed embryo.

- In somatic cell nuclear transfer (SCNT) clones, the oocyte nucleus comes from the donor organism and, as such, has undergone multiple rounds of chromosome replication during cell division and the normal aging process. In the normal sexual reproductive process, the telomere length is restored during embryo development. In SCNT-derived animals, chromosomes may have shortened telomeres. There is concern that in animals cloned from adult animal cells, the shortened telomeres will lead to health problems usually seen in older animals (Schaetzlein & Rudolph, 2005).

### 9.8.3 Regulations

In Canada, biotechnology-derived animals (e.g., animal clones and transgenic animals), their progeny and their derived products are subject to the same rigorous health and safety regulations that apply to conventional animals and their derived products under the *Health of Animals Act* and *Regulations*, the F*ood and Drugs Act* and *Regulations*, the *Meat Inspection Act* and *Regulations*, and the *Feeds Act* and *Regulations*, administered by the Canadian Food Inspection Agency (CFIA) and Health Canada. In addition, animal clones are considered as "novel" or "new", triggering additional regulations administered by a number of organizations: Health Canada for food safety and indirect human health effects; the CFIA for feed safety, animal health and welfare, and enforcement of food standards and regulations; and Environment Canada for environmental release.

In July 2003, as an interim policy, Health Canada stated that foods produced from livestock developed using SCNT cloning and from the progeny of such livestock are considered to fall under the definition of "novel food." Novel foods are subject to the regulations in Division 28, Part B, of the *Food and Drug Regulations*. Developers producing animal clones through SCNT must, therefore, not introduce the products or by-products of any animal clones or their progeny to the human food supply in Canada, unless they have been subject to the pre-market safety assessment required for novel foods. However, as there is currently insufficient data to guide the pre-market safety assessment of these products, developers who wish to use SCNT technology for producing livestock are requested to withhold novel food notifications until requirements are determined and guidance is available. This interim policy is posted on the Health Canada's website: http://www.healthcanada.gc.ca/novelfoods.

The Feed Section of the CFIA also considers products and by-products derived from SCNT animal clones and their progeny to be "novel feeds"; therefore, notification and assessment is required before any derived products from these animals are released in the feed chain. This assessment considers the safety of the feed to livestock, to humans via worker/bystander exposure and consumption of animal products, and to the environment. More information regarding the use of products and by-products derived from SCNT-animal clones into feeds can be found at http://www.inspection.gc.ca/english/anima/feebet/bio/bfeebete.shtml.

SCNT-animal clones, their progeny and their products and by-products are also considered "new substances" under the *Canadian Environmental Protection Act (CEPA)*, 1999 and require notification under the *New Substances Notification Regulations – Organisms*. Prior to import or manufacture in Canada, manufacturers and importers of such substances are required to supply to the Minister of the Environment the information prescribed in these regulations that will allow this Minister and the Minister of Health to perform a risk assessment to determine if the new substance poses a risk to the health of Canadians and to the environment. More information regarding the requirements for notification of new substances is posted on Environment Canada's website:

http://www.ec.gc.ca/substances/nsb/eng/notify_e.shtml.

### 9.8.4 Tracking

**Guideline 48:**

**Genetically-engineered animals should be given at least two separate types of identification.**

It is recommended that individual animals be identified with at least one unique, permanent means of identification (e.g., microchip or tattoos) and at least one visual, easy to read, method of identification. This permits individuals to be tracked, and provides a means to account for each and every individual at all times. Redundancy provides back-up identification in case the permanent means of identification is faulty, destroyed or lost (e.g., in the case of a tattoo or of an ear tag, using an additional mean of identification such as a microchip is prudent). Record-keeping on the nature and method of the genetic manipulation associated with each animal is mandatory. Currently, the Canadian Cattle Identification Agency (http://www.canadaid.com) provides records and tracking of cattle through its tags. Efforts are on-going to link DNA markers with the genetic modifications, and to use that as a tool to identify genetically-engineered livestock.

Proper animal identification is necessary to provide individual care and follow-up on health and welfare, and in some cases production levels. In some instances, regulatory agencies will specify the required means and level of identification of farm animals derived from biotechnology. For some species, certain breed associations have opened a specific registry for genetically-engineered animals.

### 9.8.5 Confinement

**Guideline 49:**

**Genetically-engineered animals should be confined within at least two physical barriers at all times.**

**Guideline 50:**

**Access to facilities confining genetically-engineered animals should be restricted to authorized personnel.**

To avoid accidental release of genetically-engineered farm animals into the environment, it is important that more than one level of effective confinement be used. For example, a genetically-engineered animal can be confined in a barn and within a pen or a stall. However, when the animals are out of their pens/stalls, only the barn walls confine the animal; in the case where a door is kept open, the animal could then escape. This could pose a potential problem, specifically in a farming community, if a genetically-engineered farm animal escapes and is accidentally adopted by a neighbouring conventionally-bred herd. It is therefore recommended that there be at least two levels of confinement (in this example, a closed fence outside the barn) at all times.

In all cases, and especially where the animal housing is located on a public property, SOPs should be in place to address the issue of confinement in relation to security procedures, making it unlikely for someone to release or take an animal outside its designated housing facility. A log should be maintained and strict procedures should be in place to screen visitors as well as vehicles entering or leaving the facility.

Facilities must follow any specific municipal by-law and provincial or federal regulations which specify the confinement and security levels for livestock derived from biotechnology.

### 9.8.6 Transportation

**Guideline 51:**

**Biosecure transit must be in place for transfers of all genetically-engineered animals to preclude their accidental release.**

Caution must be applied when transporting genetically-engineered animals. Such animals could be the cause of undesirable genetic propagation if they escape in transit, although large farm animals are more easily spotted and retrieved than fish or laboratory rodents. Regulatory agencies may have specific rules and regulations related to security and biosecurity for the transport of certain genetically-engineered animals. Environment Canada, for example, recommends that transportation companies and drivers have experience in the handling of animals in case of accidental release, and a back-up plan should be prepared to handle such unintended releases.

Transportation is, in most cases, a stressful event for a farm animal. The species-specific recommended codes of practice listed on the National Farm Animal Care Council website (http://www.nfacc.ca/code.aspx) and the *Recommended Code of Practice for the Care and Handling of Farm Animals – Transportation* (CARC, 2001) should be consulted for guidance. The effect of the genetic modification on animal physiology, such as possibly suppressed immune systems, must be dealt with on a case-by-case basis. The method of transportation must be taken into consideration and be adapted to any recommended transportation procedures for such animals. It is recommended that genetically-engineered animals be transported separately from conventional animals, so as to reduce the chance of mixing of animals.

### 9.8.7 Care and nutrition

Genetically-engineered animals should be cared for by qualified personnel. Observation, along with specific tools to allow systematic wellness assessment and follow up, are important (*CCAC guidelines on: genetically-engineered animals*, in prep.). However, depending on the genetic modification, if the animals are intended for food or for pharmaceutical production, the genetically-engineered farm animal may require special care (e.g., caesarian-section for parturition if offspring are excessively big, or additional veterinary surveillance, intervention and mitigation for immune-depressed animals). Some of the common problems encountered in production of such animals include decreased or absent suckling reflex, organ insufficiencies, umbilical hernias and endocrine disturbances, all of which need veterinary supervision. Characterization of the effects of the genetic modification on the animal's physiological state permits the development of strategies to mitigate any adverse consequences for the animal. This information, gathered at the research stages specific to each species, is necessary to analyze and determine optimal animal care and nutrition practices. An information package for each modification can then be prepared, which should accompany the animal when used commercially (subject to regulatory approval of such animals). During the research stage, close observation is necessary in order to prepare guidance on optimal care of the animal (*CCAC guidelines on: genetically-engineered animals*, in prep.; Expert Panel on Husbandry of Animals Derived from Biotechnology, 2001).

The guidelines for husbandry practices, including reproduction and nutrition, as described in Section 10. Species-Specific Considerations for the various types of conventionally-bred farm animals, should be followed. These general guidelines should be used as a basis for more specific guidance, depending on the particular genetic modification.

The physiological pathways of genetically-engineered farm animals may be altered by the genetic modification, resulting in differences in well-established nutrient requirements. Therefore, a conventional feeding program may have to be adapted to ensure optimal animal health. There could be differences in digestibility and absorption of nutrients, for example, which could lead to changes in nutrient requirements; in turn, this could result in new levels of nutrient availability, causing deficiencies and/or toxicities.

Furthermore, the end use of the genetically-engineered farm animal may dictate changes to conventional practices, for example, excluding all animal by-products from the diet to eliminate risks of Transmissible Spongiform Encephalopathies (TSEs), or using a pesticide (herbicides and fungicides) free feed for genetically-engineered farm animals producing pharmaceuticals in their milk. In cases where farm animals are kept indoors continually (genetically-engineered or not), provisions may have to be made to include vitamin D in the ration, since the animals are not exposed to sunlight.

A genetically-engineered farm animal producing a recombinant protein in its milk might not be permitted to nurse its offspring due to the value and safety of that novel recombinant protein; therefore, adequate feeding of the offspring must be planned and provided (for dairy animals, well established feeding practices are commonly available, see Section 10.1.3.2). If the offspring is also genetically-engineered, the feeding program may need to be adapted to fulfill the animal's nutrient requirements.

# 10. SPECIES-SPECIFIC CONSIDERATIONS

## 10.1 Dairy Cattle

### 10.1.1 Facilities and facility management

#### 10.1.1.1 Engineering and design

**Guideline 52:**

**Regardless of the type of housing used for dairy cattle, there must be a dry, comfortable lying area for every animal.**

Adult dairy cattle generally need to lie down for about 12 hours per day, although this will vary according to the age and stage of lactation.

Injury or death associated with entrapment is an indicator of poor design of stalls, feeders or flooring, or problems with movement of animals through indoor facilities (e.g., narrow doorways), which should be corrected.

Where possible, a pasture area should be available for use by dairy cattle in the summer, with the provision of shade in areas where heat and humidity are high.

#### Group housing

**Guideline 53:**

**Group penning facilities and feeder design should be of appropriate scale for the breed and size of cattle housed.**

Group-housed cows should be provided with adequate feeding space. There should be at least one feeding position per cow or at least 60 cm of feeding space, depending on the type of feed line barrier. It is recommended that cows be provided with more feeding space than the current industry standard (60 cm) to improve access to feed and reduce aggressive interactions while feeding (DeVries et al., 2004), particularly around calving time when cows are most vulnerable. Elevating the feeders 15-20 cm above the floor level, and providing a wall 37-50 cm high to retain the feed close to the cows, will reduce the pressure that cows exert on the stall fronts when feeding. Feeders should be designed to provide easy access to feed, be easy to clean, and not injure the animals.

#### Stalls

Institutions constructing new facilities for dairy cattle should design them to allow for group housing or free stall accommodation. In order to provide cows with sufficient freedom to express normal behaviour, the use of tie stalls is discouraged.

The design of stalls for dairy cows should take into consideration the size, shape and weight of the animals. A well-designed stall permits a cow to stand comfortably with all four feet on the cubicle bed. It should be wide enough for the animal to rest without undue pressure on the body, which could restrict rumination or cause damage to the legs and udder. Space must be adequate for cattle to lie down and stand up in a normal manner. The length of the stalls must permit animals to shift their body weight forward and backward in order to rise up with minimal effort. There should be a gentle downward slope from the front (head end) to the back of the stall to ensure adequate drainage. A well-designed stall should ensure that cattle do not spend long periods standing with their hind feet in the gutter. Curb height and stall length are important: a curb that is too high puts strain on the hind legs of animals that stand in this manner; however, the curb should be high enough to prevent the bed of the stall from becoming contaminated.

**Guideline 54:**

**Where dairy cattle are housed with free stalls, there should be at least one stall for each cow within the group.**

It is preferable to provide extra stalls, since not all stalls are equally used by cows. Stalls that are too small will reduce the time that cows spend resting in the stall and will increase the risk of lameness and mastitis. Detailed recommendations are available for appropriate stall sizes for cows of different weights (Bickert et al., 2000), and these should be followed (see Table 6). As a general rule, free stalls for adult Holstein cows should be 106-132 cm by 230-290 cm. However, where animals of different sizes are housed together, the stall dimensions should be suited to the largest animal (Anderson, 2003; Nordlund & Cook, 2003). Selection for high milk production has resulted in ever larger cows, and recommended sizes need to be continually updated. Observations of cows suggest that when adult Holstein cows lie down, they take up a longitudinal space of approximately 200% of their back length (hip to shoulder) and a lateral space of 120-180% of their hip width (Ceballos et al., 2004). Stalls need to be designed to allow for this extent of movement.



### Table 6 Minimum Area for Dairy Cattle Used in Science Housed in Free Stalls

| Animal Size | Stall Requirements | |
|---|---|---|
| | Width | Length |
| 365-545 kg | 107 to 112 cm | 230 to 244 cm |
| 545-680 kg | 112 to 122 cm | 244 to 260 cm |
| over 680 kg | 122 to 132 cm | 260 to 275 cm |

Adapted from Bickert (1999)

If dairy cattle are kept in tie-stalls, appropriate stall design is very important to the welfare of the animals. The front of the stall should not prevent the animal placing its head over the feed area when lying down. The stalls need to be wide enough to house the largest cows normally found in a herd. Stalls that are too narrow may reduce the time that the animals lie down or may increase the risk of injury when the animals lie down or stand up. Stalls that are too short increase the risk of cattle standing with their hind feet in the manure gutter (if it has no cover), increasing the risk of lameness and reducing cleanliness. However, stalls that are too long often become soiled and an electric or other form of cow trainer may be necessary. Where electric cow trainers are used, these should be placed at an appropriate height so that they do not touch the cow when she is standing normally. The use of electric cow trainers has been associated with an increased risk of mastitis (Oltenacu et al., 1998), and alternatives should be explored.

The tether chain should be long enough so that the cow can groom itself and lie down with its head turned back and resting comfortably upon its flank.

### Maternity pens

For dairy cattle that do not calve at pasture, a separate calving area or maternity pen should be provided. Non-slip flooring with bedding is essential for the maternity pen, as the number of transitions from lying to standing increases significantly during the calving event (Huzzey et al., 2005). A recent recommendation for the minimum size of the calving area is 15 $m^2$ (Davis & Drackley, 1998).

### Housing for calves

Wherever possible, dairy calves should be kept in groups of less than 10 animals, with at least 2.5 $m^2$ per calf (Davis & Drackley, 1998). Older, weaned calves should have access to pasture wherever practical.

Where individual housing is used for milk-fed calves, pens must be large enough to allow the calves to lie flat on their sides with all legs fully extended, to stand up and lie down with ease, and to turn around. A minimum width of 1.5 m and an area of at least 2.5 $m^2$ are required. Where outdoor plastic or wooden hutches are used, these should have an opening to allow the calf to step outside, and to provide some ventilation. Calves should not be tethered.

Whether group or individually housed, a dry bedding area for lying should be provided for milk-fed calves at all times.

Good, draft-free ventilation is essential to maintain the health of calves, especially those that are milk-fed. Natural ventilation is preferable.

### Housing for bulls

Mature bulls housed in groups routinely fight each other to the detriment of themselves and the research facilities. Even when bulls are individually penned, specialized, highly-durable facilities are required for handling and housing bulls, and planned, protected escape routes are needed for staff.

In insemination centers, bulls should be housed individually.

### Chutes & raceways

Requirements for chute and raceway systems for cattle facilities will depend on the type of animal resident at the facility. If pregnant cows are maintained, chute systems should be designed to facilitate pregnancy testing.

In case of a difficult birth, an obstetrical squeeze with side walls that open to allow access in case of caesarean section or use of calf pulling devices is imperative.

### Housing for sick or injured cattle

Sheltered, well-bedded 'sick' pens should be available for cattle that fail to thrive due to disease or injury.

### 10.1.1.2 Water supply

Provision of potable water in appropriate volumes is very important. When water is delivered in individual drinkers, the water pressure must be sufficient to deliver it at a rate that is compatible with the rate of drinking for the breed. This is particularly important for cows in tie-stalls. A rate of 10 L/min for each cow is recommended. In addition, water pipes delivering water to the housing facility should be large enough to provide water under sufficient pressure for cows to drink and cleaning routines to be performed simultaneously. For group-housed cattle, the design and location of water sources should ensure easy access to water for all cows. Water sources must also be designed so that they are easily cleaned. If water comes from a well, the water quality must be checked regularly.

### 10.1.1.3 Floors

**<u>Guideline 55:</u>**

**Most flooring inside cattle barns should be compressible, provide good traction, and be well drained.**

To ensure optimum mobility of dairy cows, dry, compressible flooring that provides good traction should be used for cattle housed indoors (Rushen & de Passillé, 2006). Wherever possible, the amount of time that cattle spend standing or walking on concrete floors should be minimized. Hard, wet floors increase the chance of hoof injuries, and use of concrete floors has been associated with an increased incidence of lameness among dairy cows (Somers et al., 2003; Vanegas et al., 2006).

Compressible flooring could be in the form of rubber, straw, etc. Rubber mats placed in front of feed bunks increase the time that cattle spend at the feeder and reduce the time they stand in their stalls (Fregonesi et al., 2004; Tucker et al., 2006). Flooring in walking areas should provide adequate traction. Hard rubber mats should be sufficiently grooved or textured to allow the feet to grip even when wet. If concrete is used, it should be grooved, and must not have sharp protrusions that will damage the hooves of the cows. Good drainage of flooring is essential: standing in chronically wet conditions damages the interdigital skin and heel of the hoof and increases the risk of hoof disease, and reduces the hardness of the hoof (Borderas et al., 2004).

Use of fully-slatted floors requires careful monitoring of air quality, especially when manure remains under the slats for more than 12 hours. Slatted floors may also increase the risk of hoof and leg damage (Hinterhofer et al., 2006) unless alternative laying areas are provided to the cattle. Alternative flooring materials that are less likely to cause trauma than concrete should be used if slatted flooring is essential. Otherwise, it is recommended that other methods of housing and manure/feces removal be explored. If a cable-drawn alley scraper is used, the cable must be regularly inspected for fraying to avoid hoof injuries. A 2 cm groove cut in the floor to house the cable will minimize injury to animals from standing directly on the cable.

#### Outdoor surfaces

Where cattle are housed outdoors, attention should be paid to the quality of walking tracks. These should be well maintained, even, and not contain sharp stones or other materials likely to lead to hoof and leg injury.

#### 10.1.1.4 Environmental control

Cattle have an excellent tolerance of low temperatures, as long as ample feed is supplied. However, newborn and milk-fed calves can be adversely affected by cold; when calving occurs in cold weather, new born calves should be provided with draft-free shelters and dry bedding.

Cattle are sensitive to heat stress, which can begin to occur when temperatures rise above 25°C. This is particularly true of milk-fed veal calves and lactating dairy cows that generate considerable metabolic heat. An increased and laboured respiration rate is a sign of heat stress. Cattle must be provided with protection against heat. Those housed indoors should be provided with adequate ventilation to reduce heat load, while dairy cattle housed outdoors should be provided with adequate shade.

Indoor cattle facilities should be fitted with equipment for monitoring temperature and humidity, and appropriate means should be available to deal with extra heat loads (e.g., extra fans or ventilation and water sprinklers). Sprinklers should not be used when humidity is high.

Sufficient lighting should be provided so that all animals can be inspected properly at all times. Between 8 and 18 hours of lighting per 24 hours is suggested.

### 10.1.2 Acquisition, transport and quarantine

Transportation and pre-slaughter management of dairy cattle are subject to legal requirements set out in the *Regulations* under the *Health of Animals Act* and the *Meat Inspection Act*. Other recommendations are provided in the *Recommended Code of Practice for the Care and Handling of Farm Animals – Transportation* (CARC, 2001, http://www.nfacc.ca/code.aspx). Staff should receive training in good handling practices to facilitate the loading and unloading of all ages of cattle, and in the identification of those animals which should not be transported.

Cattle should be closely inspected upon arrival to ensure their good health, and placed in quarantine facilities in accord with established herd health protocols. In particular, cattle should be under frequent veterinary inspection until a suitable quarantine period has passed. Appropriate remedial measures should be taken for those animals which are found to be injured or otherwise in ill health upon arrival.

**Guideline 56:**

**Dairy calves should not be transported or brought into the facility unless they are healthy, have been fed colostrum, and have a dry umbilicus. Calves should be at least one week of age.**

Dairy calves under one week of age should not be purchased, except when this is essential for experimental purposes and has been prearranged with selected producers. In cases where younger calves are required, they should not be transported until the navel is dry, and should be moved only in enclosed, bedded transport vehicles. Any calves that are purchased should have received sufficient colostrum and be in good health. Transfer of passive immunity should be checked (at least mbc 10 mg/ml IgG) (*Health of Animals Act*, Part 12). Calves should not be transported for longer than eight hours and should only be transported on dry bedding with sufficient space to lie down.

**Guideline 57:**

**Dairy calves should not be purchased from sources that do not provide them with sufficient colostrum.**

Information on sufficient colostrum levels is provided in Section 10.1.3.2 Feed and water.

There should be a veterinarian-approved program of prophylaxis for newly received calves.

## 10.1.3 Husbandry

Cattle housed indoors should be checked at least twice daily for injuries, especially to the legs and neck. Common injuries include fractures or soft tissue trauma to limbs, especially swollen or bruised knees and hocks. In addition, dislocated and 'knocked-down' hips and fractured jaws are sometimes seen. Reasons for these injuries should be investigated and corrected.

### 10.1.3.1 Housing and animal management

#### Access to pasture

**Guideline 58:**

**Wherever possible, dairy cattle should have access to pasture in the summer months.**

Research has shown that access to pasture can reduce the incidence of various health problems such as mastitis, metritis and lameness (Waage et al., 1998; Wells et al., 1999; Bruun et al., 2002; Somers et al., 2003; Haskell et al., 2006; Hernandez-Mendo et al., 2007).

#### Management of cattle housed in tie-stalls

**Guideline 59:**

**Dairy cows kept in tie-stalls should be allowed a period of exercise every day.**

Cows kept in tie-stalls should be allowed a period of exercise every day unless experimental procedures or inclement weather preclude it. This also allows assessment of mobility and other health problems. Moving cows in and out of tie-stalls should be done with care and slowly so that they do not fall and injure themselves.

#### Management of housing for calves

**Guideline 60:**

**Where possible, dairy calves should be housed in groups with appropriate management.**

Group housing for milk-fed calves is becoming more common and has the advantage of allowing calves greater opportunities for physical exercise as well as social contact. However, poorly managed group housing can increase the incidence of infectious diseases. Where group housing is used, appropriate management techniques should be adopted to control diseases. For example, group size should be sufficiently small to allow each calf uninhibited access to lying areas, feeders and water sources, as well as to ensure easy observation of the animals by personnel to detect health problems. Recent research suggests that group sizes less than 10 may reduce mortality and morbidity (Losinger & Heinrichs, 1997; Svensson et al., 2003). Groups of milk-fed calves should be managed in an all-in-all-out manner, and where possible, the pens should remain empty for a period of time after a group of calves has been removed.

#### Management of housing for bulls

Dairy bulls can be dangerous; they are unpredictable and may be aggressive to humans and other bulls. When working with bulls, extreme caution is advised, particularly in confined situations. New bulls should not be introduced to an existing pen of bulls, as injury, especially to the new animals, is likely from fighting to determine dominance.

### 10.1.3.2 Feed and water

Lactating cows are normally fed diets consisting of 50% forage and 50% concentrate to increase milk production. Cows that preferentially sort for grain or consume diets higher in grain can be at risk for acidosis, liver abscesses and laminitis. A gradual transition from forage-based to grain-based diets is essential to minimize the risks of such health problems.

Cattle generate considerable metabolic heat, which can increase heat load during hot weather. Rations should be manipulated to reduce heat stress.

Vertical (sand) cracks in the hooves of pastured cattle may be a sign of vitamin or mineral deficiency, or other nutritional problem (Hand et al., 1992). Intervention such as hoof trimming or culling of animals may be required, as a year of nutritional supplementation may be necessary for complete repair of the hoof. Overweight cattle are more susceptible to sand cracks, and a predisposition to sand cracks has been genetically linked.

Cattle drink prodigious quantities of water and should have *ad libitum* access to clean water. Lactating dairy cows drink 80 to 120 L/day (Huzzey et al., 2007). Much of this is consumed during feeding and after milking.

Drinkers must be checked daily to ensure animals always have access to water and the water remains free of ice. Individual or group drinkers must be cleaned weekly, or more often if they become contaminated.

*Nutrient Requirements of Dairy Cattle*, developed by the National Research Council (2001), should be viewed as minimum requirements.

### Calves

**Guideline 61:**

**A Standard Operating Procedure for colostral management and feeding to dairy calves should include regular testing of colostrum quality, as well as calf serum immunoglobulin levels.**

An adequate intake of colostrum is essential for new born calves to ensure they have sufficient immunological protection. Inadequate colostrum intake will increase the risk of pre-weaning mortality and morbidity. A minimum serum concentration of 10 mg/ml of IgG indicates successful passive transfer of immunity. To achieve this, calves should ingest at least 6 L of good quality colostrum during the first 24 hours after birth. For dairy calves, this can best be achieved by feeding 4 L as soon as possible after birth, and then a further 2 L at or before 12 hours after birth (Davis & Drackley, 1998). Dairy calves that suckle their dam for only a few hours after birth may not ingest sufficient colostrum, and therefore, this quantity should be provided by hand. Colostrum that is refused should be fed with an esophageal feeder by an experienced person. Successful transfer of passive immunity should be checked; commercial test kits are available for this purpose.

Colostrum can be collected and frozen from cows in the herd with an abundant supply to better match antibody requirements of calves at the research site. Colostrum quality should be checked using a colosterometer, and colostrum must be handled in a hygienic fashion to prevent contamination. Frozen colostrum should be used or discarded within a 1-year period.

To avoid white muscle disease in young calves, pregnant cows should be injected with vitamin E/selenium at least 1 month prior to the expected calving date. In severely deficient areas, additional selenium supplementation to calves may be necessary.

**Guideline 62:**

**Milk-fed dairy calves should be fed a quantity of milk equivalent to at least 20% of their body weight per day.**

Current industry guidelines for the amount of milk or milk replacer fed to milk-fed calves (about 10% body weight per day) are now recognized as being too low to allow normal growth (Jasper & Weary, 2002; Khan et al., 2007). These low amounts of milk increase the incidence of cross-sucking when milk-fed calves are kept in groups (Jung & Lidfors, 2001), and increase the occupancy of automated milk feeding systems (Jensen, 2006) and competition for teats between calves (De Paula Vieira et al., 2008). Feeding milk at a rate of at least 20% of body weight per day allows for normal growth and does not lead to any health problems such as scouring, provided that the calf does not drink the milk too quickly or drink too much in one meal.

Calves respond to cold with increased feed intake. Extra feed should be provided to calves when environmental temperature drops below 10°C (Davis & Drackley, 1998), and milk should be fed at body temperature.

Unweaned calves should also have *ad libitum* access to fresh water, even when fed milk replacers. Clean, fresh water should always be used to prepare milk replacers.

### 10.1.3.3 Bedding

**Guideline 63:**

**Dairy cattle should have adequate bedding.**

Cattle should not lie on bare concrete floors. Floors that are too hard increase the incidence of tail injuries, swollen knees and hock abrasions (Weary & Taszkun, 2000).

Deep straw or sawdust is the most common form of bedding used for dairy cows. Straw is preferable to sawdust, and if sawdust is used it should be cleaned regularly to ensure a dry bedding area. For lactating dairy cows, use of organic bedding may increase the risk of mastitis. In such cases, clean sand or manufactured soft, rubber mats or cushioned mattresses with a small amount of bedding are suitable alternatives (Tucker & Weary, 2004; Zdanowicz et al., 2004).

#### Maternity pens

Maternity pens must be provided with adequate clean bedding to keep the cow and calf clean and dry. Only one cow at a time should use the calving area, and bedding must be changed and the pen sanitized between animals.

#### Calves

A dry bedding area with a minimum depth of 15 cm is recommended (Davis & Drackley, 1998). Bedding must be added or replaced regularly in order to keep the calves clean and dry. Calves should not lie on bare wooden or concrete floors. Adequate bedding and energy-rich feed is particularly important for calves in cold housing during the winter months.

### 10.1.3.4 Environmental improvement

Loose-housed dairy cattle will often use brushes that are suspended from the roof or attached to the walls or pen fixtures. These likely help to keep the cows clean and may reduce some skin parasites (DeVries et al., 2007).

**Guideline 64:**

**Milk-fed dairy calves should be fed milk through teats.**

Milk-fed calves that are group housed often engage in cross-sucking. This behavior can be reduced by allowing calves to drink sufficient quantities of milk, by allowing the calves to suck on artificial teats either during or after drinking, and by allowing access to hay (de Passillé, 2001; Jung & Lidfors, 2001; Jensen & Budde, 2006). In addition, providing milk through a teat rather than a bucket does not appear to affect health or growth rates, but increases relaxation in the calf after the meal (Veissier et al., 2002).

Calves should be fed using artificial teats or, if bucket-fed, should be provided with artificial teats for 10 minutes after the meal. When group-housed calves are fed with automated feeders, these should be fitted with a privacy gate to prevent calves being displaced from the feeder.

### 10.1.3.5 Human contact and handling

**Guideline 65:**

**Employees responsible for handling cattle should receive instruction in low-stress methods of handling.**

Rough handling has been shown to be a source of stress for cattle of all ages. Cattle recognize individual people and become frightened of those who handle them roughly (Rushen et al., 1999). Cattle can also become frightened of places where they have been handled roughly. Aversive (painful or frightening) handling, such as tail twisting, shouting and hitting, is unacceptable.

**Guideline 66:**

**The electric prod must not be used in routine handling.**

Striking instruments and electric prods should never be necessary for moving animals. Aids for moving animals such as panels, flags, plastic paddles, flappers (a length of cane with a short strap of leather or canvas attached), plastic bags and metallic rattles should be used for this purpose. Objects such as metal piping, fencing wire or heavy leather belts should not be used. Shouting or yelling at animals or making loud noises (e.g., through the cracking of whips to encourage them to move) should not occur as such actions may agitate the animals and lead to crowding or falling. In rare and extreme situations, the use of cattle prods may be required for the animal's own welfare, but electric prods must never be used on sensitive body parts such as the face, anus and reproductive organs.

When handling mature bulls, research staff must use extreme caution and never work alone. Bulls are unpredictable and may behave aggressively to humans and other bulls.

#### 10.1.3.6 Restraint

Equipment for restraining cattle should be properly designed and well maintained to avoid injury to animals and research staff. Non-slip flooring and good lighting will encourage animals to enter races and squeeze chutes. Head gates should be designed so that cattle will not choke if they go down in the chute.

Restraint periods should be minimized in order to reduce stress levels. Research staff should remain calm throughout the restraint process, and should remember to use good animal handling practices.

#### 10.1.3.7 Routine husbandry practices

Routine procedures such as artificial insemination and rectal palpation for pregnancy diagnosis are not considered invasive in the context of this guidelines document. However, these procedures should be carried out only by trained and competent individuals, to ensure that the impact on the animals is minimized.

Bulls undergoing routine semen collection should be trained to mount a mechanical dummy cow, as electro-ejaculation is stressful. Electro-ejaculation should only be conducted by experienced staff members, and used when training bulls to mount is not practical (such as for large-scale individual testing). Equipment used for electro-ejaculation should be well maintained. Improper probe positioning or excessive duration of electro-ejaculation may lead to temporary paralysis, loss of muscle control and animal injury.

#### 10.1.3.8 Routine invasive agricultural practices

##### Castration

<u>**Guideline 67:**</u>

**Anesthetics and analgesics should be used for castrating cattle.**

See Section 10.2.3.8

##### Dehorning

Horns are removed from cattle in order to minimize the risk of injury to animals and handlers. Polled dairy cattle are becoming available, and research institutions are encouraged to use such animals where possible.

<u>**Guideline 68:**</u>

**Adult cattle should not undergo dehorning procedures.**

Horns should be removed before 3 months of age. Whenever possible, young animals should be disbudded to prevent growth of horns. However, once the horns are well established, dehorning is the only option. For calves less than 2 months of age, use of a heated disbudding iron applied over the horn buds produces levels of plasma cortisol equal to using a dehorning scoop (Wohlt et al., 1994); for either procedure, an anesthetic and analgesic should be used. Horn buds of calves can also be removed using a caustic paste, and this appears to be less painful than hot-iron disbudding, especially if used with a suitable sedative (Vickers et al., 2005). However, care must be taken to ensure that the caustic paste does not spread to other parts of the calf or to other animals. Once the horns are fully vascularized, dehorning requires cutting with a saw or cutting wire, and the exposed blood vessels must be cauterized to prevent hemorrhage. Horn shears must not be used as they can cause significant blood loss.

<u>**Guideline 69:**</u>

**Disbudding and dehorning are painful and stressful procedures, and effective pain control methods must be used.**

Local anaesthetics can reduce pain responses during hot-iron dehorning, but do not provide adequate post-operative pain relief since many local anaesthetics are effective for only 2 to 3 hours after administration. Use of non-steroidal anti-inflammatory drugs (such as ketoprofen, which is licensed for cattle and horses only), in addition to a local anaesthetic, can reduce pain for a longer period of time (Stafford & Mellor, 2005a). In addition, calves being dehorned require restraint, which can be stressful; use of a sedative (such as xylazine) can essentially eliminate the need for physical restraint (McMeekan et al., 1998; Faulkner & Weary, 2000; Vickers et al., 2005).

### Cattle identification

#### *Branding*

**Guideline 70:**

**Cattle should not be branded. Where branding is essential or required by law for identification, then only one brand should be used.**

Hot-iron branding is a very painful procedure (Schwartzkopf-Genswein et al., 1997a) and should be phased out. Alternative means of identifying cattle should be used whenever possible. Freeze branding is also painful, but less so than hot-iron branding (Schwartzkopf-Genswein et al., 1997a,b). If hot-iron branding is unavoidable, it should be done as quickly as possible, using as few brands as possible. Composite brands should not be used. Some pain control methods (e.g., anti-inflammatories and/or analgesics) should be used. Cattle must not be branded on the face.

#### *Tagging*

Ear tags must be inserted carefully to avoid infection and further injury. Infections or injuries at the site of tags should be treated. An excessive number of ear tags (>1 per ear) should be avoided by using only tags required by the Canadian Cattle Identification Agency.

#### *Tail docking*

**Guideline 71:**

**Dairy cattle must not be tail docked.**

Tail docking is a controversial procedure carried out in some North American commercial dairy herds. There is little evidence that tail docking improves udder health or improves cleanliness of cows (Tucker et al., 2001; Schreiner & Ruegg, 2002; Stull et al., 2002). The procedure of removing the tail does not appear to cause much pain or distress (Tom et al., 2002a,b), and there appears to be no advantage in providing local anaesthetics or in tail docking young calves rather than adult cows. However, cattle without tails suffer from increased fly problems (Eicher et al., 2001). Furthermore, tail docking leads to neuroma formation, suggesting that some tail docked cattle may suffer chronic pain (Eicher et al., 2006). The Canadian Veterinary Medical Association has adopted a position statement opposing the docking of tails of dairy cattle (http://canadianveterinarians.net/ShowText.aspx?ResourceID=25).

The practice of tail docking was thought to reduce transmission of diseases such as Leptospirosis to workers; however, other measures, such as improved worker hygiene, have been shown to be more effective in controlling disease transmission (Mackintosh et al., 1980). Tail docking is often performed to increase the comfort and the convenience of the milker, especially in parlours where the cows are milked from the rear. Alternative management aids should be sought to alleviate this problem.

### 10.1.3.9 Parturition and caring for young

Pregnant cows should be closely monitored during the final weeks before calving and introduced to the calving area at least 3 days before the expected calving date.

Information on housing and husbandry of calves is provided in the following sections: 10.1.1.1 Engineering and design; 10.1.3.1 Housing and animal management; and 10.1.3.3 Bedding. Information on feed and water for calves is found in Section 10.1.3.2.

### Difficult births and caesarian section

Caesarian sections should normally be performed by a veterinarian, and with the use of appropriate anesthesia and post-operative analgesia.

When using mechanical calf-pulling devices, care should be taken not to apply excessive force that may impair the mobility of the calf due to ligament or nerve damage, or cause soft tissue damage to the cow, which can result in bruising, infection and possibly nerve damage. Use of mechanical calf-pulling devices should be used only when necessary and by properly trained and experienced staff.

### 10.1.3.10 Health and disease control

**Guideline 72:**

**A program of preventive health care should be established in consultation with a veterinarian.**

Accurate health records should be maintained, in particular for transition cow diseases such as mastitis and metritis. The use of detailed records contributes to overall herd health by facilitating tracking of trends, and enabling factors which may contribute to the disease to be identified and remedied.

### Calves

**Guideline 73:**

**Incidence of mortality among unweaned dairy calves should be recorded, and should be kept below 2%, excluding cases of stillborns.**

All systems maintained under good management should be able to achieve a mortality rate of <2%. Milk-fed calves (veal calves and replacement heifers less than 75 days of age on milk or milk replacer diets) often suffer from respiratory and/or enteric disease, and these are the major causes of mortality in young calves. Respiratory disease is often a result of housing problems (e.g., poor ventilation, high humidity, high stocking densities, temperature fluctuations and ammonia), mixing of age groups, poor passive transfer of immunoglobulins and other stressors. Enteric disease may be dietary in nature (e.g., poor quality milk replacer or improper feeding regime), but may also be due to infectious causes that are exacerbated because of environmental contamination of bedding and/or feeding equipment. Calves are at greater risk if they also suffer from poor passive transfer of immunoglobulins.

The health status of milk-fed calves should be checked several times each day. Signs of depression, anorexia, coughing or diarrhea should be noted and appropriate treatment should be instituted.

### Mastitis

**Guideline 74:**

**Incidence of dairy cows that develop mastitis during a lactation should be kept as low as possible, and below 15%.**

All systems maintained under good management should be able to maintain an incidence of mastitis <15%. Predisposing conditions for mastitis include dirty cows and bedding, as well as poor milking hygiene.

### Hoof and leg health

**Guideline 75:**

**Records of the incidence of lameness and hoof lesions should be maintained. The incidence of lameness among lactating dairy cows should be kept below 10% per lactation.**

All systems maintained under good management should be able to achieve an incidence of lameness of <10%. Lameness is a major welfare problem for dairy cattle and occurs as a result of an adverse interaction between the cow and her environment. Studies of dairy cattle on commercial farms typically find that over 20% of cows are lame at any one time (e.g., Espejo et al., 2006); however, many farms are able to maintain low levels of lameness. A study in the UK showed that over 25% of commercial herds had an incidence of lameness below 10% per lactation (Whitaker et al., 2004). It is difficult to identify lame cows, and the occurrence of lameness is likely underestimated. Generally, farmers are only aware of one-third to one-fifth of all cases (e.g., Wells et al., 1993; Whay et al., 2003). Lameness tends to be more common among larger cattle and among breeds with higher milk production.

Predisposing factors to lameness may occur long before the cow actually becomes lame. Factors can include

- inappropriate housing, particularly poor stall design and size;
- poor hygiene, particularly build up of slurry;
- poor quality walking surfaces;
- wet or poorly drained areas;
- genetic selection, concentrating on high productivity and neglecting foot shape and hind leg conformation;
- unbalanced formulation and delivery of the ration;
- too rapid change between diets;
- inadequate and unskilled foot care; and
- lack of use of footbaths when foot disease occurs.

It is essential that good management practices are in place to reduce the prevalence of lameness. Attention should be paid to the quality of the surface along which cows have to walk. In particular, the surface should not consist of sharp stones, rubble or gravel. Care should be taken when driving cows; they should not be made to hurry.

Lameness can be the result of lesions or injury to the hooves (the majority), feet or legs. The latter includes swollen knees and hocks caused by poor lying conditions and poorly designed buildings.

People handling cattle should be provided with sufficient training to detect early changes in gait of cattle that indicate the beginning of hoof or leg problems. Handlers should ensure that opportunities for observation occur, for example, by walking cattle down a passageway.

The feet of cattle should be inspected frequently, not only when they become lame. Hooves should be trimmed by appropriately trained hoof trimmers at least twice a year, especially when housed indoors, and whenever cattle become lame. More frequent hoof trimming may be necessary for cattle suffering from obvious hoof problems. Records should be kept of the occurrence of various hoof problems and lameness.

A veterinarian's assistance should be sought when cows are lame and fail to respond to treatment, or where the cause of a foot lesion is not apparent.

### Metabolic diseases

Metabolic disorders may arise with both low input systems, where nutrient supply is insufficient to meet the demands of the cattle, or with higher input systems, where feeding mismanagement can lead to digestive upsets.

The genetic make-up of the cow can be such that, in spite of reduction in nutrient input, milk output continues with consequential live weight loss due to mobilization of body reserves, causing varying types and degree of metabolic disorders. In addition, manipulation of the diet to meet certain market needs (e.g., low fat milk) requires alterations to the diet which may lead to digestive disorders and energy deficits, if not properly managed.

**Guideline 76:**

**Cattle should not be fed diets that lead to acidosis.**

Feeding high-grain diets to cattle without proper acclimation and feeding management can lead to acidosis and a variety of metabolic disturbances. Fine grinding of grain and rapid changes in diet should be avoided to prevent digestive disturbances such as bloat or acidosis. See Section 10.1.3.2 Feed and water.

### Body condition scoring

Routine weighing or body condition scoring of cattle should be done to help detect the loss of live weight that may indicate inadequate nutrition. On a five-point scale, scores of less than 2 are indicative of severe undernourishment, while scores over 4 indicate excess feed intake (Marx, 2004). Changes in feeding patterns can also indicate metabolic disturbances.

In herds kept for teaching or research, the diet of the cattle should be formulated primarily to protect the health of the animals, and appropriate corrective factors should be given when necessary. Good health should not be sacrificed to achieve higher milk production.

## 10.1.3.11 Disposal of animals

### Slaughter

See general information in Section 6.11 Disposal of animals.

The Ontario Farm Animal Council has developed a decision tree to assist in determining when animals are fit to be loaded for transport to slaughter facilities and when they should be euthanized on-site (http://www.ofac.org/pdf/Cattle_Chart_2007_5.pdf). Further information is provided by the CFIA at http://www.inspection.gc.ca/english/anima/trans/consensuse.shtml.

### Non-ambulatory animals or "downers"

**Guideline 77:**

**Non-ambulatory cattle must not be transported, except in certain exceptional circumstances such as for veterinary treatment.**

CFIA regulations (June 2005) dictate that non-ambulatory animals cannot be transported except for therapeutic reasons, such as to a veterinary hospital for treatment. All non-ambulatory (downer) cattle should be euthanized if veterinary examination determines that the prognosis for a speedy recovery is poor.

When movement of non-ambulatory animals is necessary, such as prior to transportation for veterinary treatment, animals should only be moved using slings or other suitable devices. Unless appropriate devices are available, non ambulatory animals should not be moved. Non-ambulatory animals must not be dragged.

#### Euthanasia

On-site euthanasia of cattle may be necessary in cases of severe injury or disease, or as a result of disasters such as fire, flood or emergency disease outbreaks. In research facilities, on-site euthanasia is also required where animals cannot be permitted to enter the food chain. In these instances, the animals must be killed in a humane manner that leads to immediate insensibility and minimizes fear and anxiety in the animal. The basic methods appropriate for on-farm euthanasia of cattle are overdose by barbiturate, and stunning by penetrating captive bolt, followed by bleed out. Gunshot may be used in exceptional circumstances where other methods are not feasible. Euthanasia must only be carried out by properly trained personnel.

### 10.1.4 Human safety

Cattle are potential carriers of zoonotic agents. Some examples include *Cryptosporidia*, *Campylobacter*, *Coxiella burnetii*, ringworm and others. Personnel working with cattle should be made aware of the possibility of becoming exposed to these infectious agents, and be instructed on the means to minimize the risk of exposure.

Because of their size, cattle can be dangerous animals with the ability to cause serious injury or death to handlers. With the exception of bulls, dairy cattle are rarely aggressive towards people; however, injuries can occur when cows are frightened, or when facilities or methods of handling or restraint are inappropriate. Individuals should not work alone in areas where animals can be dangerous. Facilities with protected escape routes are necessary, and personnel must exercise caution and appropriate vigilance. In the event that having more than one person in an area is not possible, communication devices should be provided to maintain contact with fellow workers.

## 10.2 Beef Cattle

### 10.2.1 Facilities and facility management

#### 10.2.1.1 Engineering and design

#### Feedlot pens

The area for feedlot pens should be 19-28 $m^2$ per animal for finishing cattle, and 16-23 $m^2$ per animal for newly-weaned calves. Feed bunk space should be 20-30 cm per animal for ad libitum fed finishing cattle weighing over 275 kg (Winchell et al., 2000), and at least 48 cm per animal for limit-fed newly weaned calves (as indicated in Table 7).

Feedlot pens should be well drained, with a dry resting area such as a raised hill. Wet, muddy pens should be avoided as they cause stress for the cattle and increase their susceptibility to disease such as interdigital dermatitis/footrot (Borg

**Table 7 Requirements for Beef Cattle Housed in Feedlot Pens**

| | Area | Feed Bunk Space |
|---|---|---|
| Finishing cattle | 19-28 $m^2$ /animal | 20-30 cm/animal for *ad libitum* fed |
| Newly weaned calves | 16-23 $m^2$ /animal | at least 48 cm/animal for limit-fed |

& Kennedy, 1996; Smith et al., 2001). Clean dry bedding should be provided when ambient temperature falls below -15°C.

Feedlot pens should be designed with windbreak fences to provide shelter from prevailing winds.

Slat width of pens should allow for 25-33% porosity to reduce drifting and build up of snow in the pen (Winchell et al., 2000).

## Group housing

**Guideline 78:**

**Group penning facilities and feeder design should be of appropriate scale for the breed and size of cattle housed.**

Group-housed cattle should be provided with adequate feeding space. There should be at least one feeding position per animal or at least 60 cm of feeding space for mature cows or bulls, depending on the type of feed line barrier. It is recommended that cattle be provided with more feeding space than the current industry standard, to improve access to feed and reduce aggressive interactions while feeding (DeVries et al., 2004). Elevating the feeders 15-20 cm above the floor level and providing a wall 37-50 cm high to retain the feed close to the cattle will reduce the pressure that they exert on the stall fronts when feeding. Feeders should be designed to provide easy access to feed, be easy to clean and not injure the animals.

## Facilities for calves and nursing cows

Beef cows calving in confinement require well-bedded group pens. Pregnant cows should be housed separately from cows with calves. Groups of cows and neonatal calves should be transferred from the calving pen to avoid stressing individual cows.

Separate facilities are required for heifers and mature cows when nursing calves. First-calf heifers may be unable to compete with mature cows at the feed bunk and may be less able to bond with their calves at the time of calving. Pregnant heifers frequently require more intervention during calving than mature cows, and more attention afterward to ensure adequate bonding has occurred.

In confinement situations, a separate lying area that cannot be accessed by cows should be provided for calves. This separate area should be bedded and dry, and can also contain high-energy feed (creep feed). In pasture situations, provision of well-bedded shelters may increase survival of young calves, especially in the first weeks after birth. Shelters may be very simple structures comprised of three sides of straw bales with a weighted board on top. If placed on a south-facing hill and with regard to prevailing winds, such a structure will generally shelter cows and new-born calves even during the most inclement weather. If the shelter's bedding becomes dirty, the bales can be moved to a clean location and the dirty bedding removed and composted.

Facilities for weaning beef calves should be designed so that cows can make visual and auditory contact with their calves while separated by a secure fence for a period of at least 1 week.

## Housing for bulls

Mature bulls housed in groups routinely fight each other to the detriment of each other and research facilities. Even when bulls are individually penned, specialized, highly-durable facilities are required for handling and housing bulls, with planned protected escape routes for staff.

In insemination centers, bulls should be housed individually.

## Housing for sick or injured cattle

Sheltered, well-bedded 'sick' pens are required for cattle which fail to thrive due to disease or injury.

## Chutes & Raceways

All beef cattle facilities should have raceway systems designed to promote the movement of cattle without undue stress (Grandin, 2007) for routine procedures such as inoculation, ear tagging, de-horning, castration, implanting and parasite control. Non-slip flooring and good lighting will encourage animals to enter races and squeeze chutes. Head gates should be designed so that cattle will not choke if they go down in the chute.

Requirements for chute and raceway systems for cattle facilities will depend on the type of animal resident at the facility. If pregnant cows are maintained, chute systems should be designed to facilitate pregnancy testing. In case of a difficult birth, an obstetrical squeeze with side walls that open to allow access in case of caesarean section or use of calf pulling devices is imperative.

#### 10.2.1.2 Water supply

Provision of potable water in appropriate volumes is very important. When water is delivered in individual water troughs (or drinkers), water pressure must be sufficient to deliver it at a rate that is compatible with the rate of drinking of the breed.

In winter, clean snow may be a suitable water source for non-lactating cattle, provided the diet has sufficient energy (Degen & Young, 1990). Provision of heated or open water will reduce feed energy requirements for beef cattle. Feedlot pens should be provided with heated water bowls to provide 3.4 L/minute/animal (Kenzie & Williamson, 2000). Water quality must be checked regularly when it comes from a well.

#### 10.2.1.3 Floors

**Guideline 79:**

**Most flooring inside cattle barns should be compressible, provide good traction and be well drained.**

Dry, soft flooring that provides good traction should be provided for cattle housed indoors. Compressible flooring could be in the form of rubber, straw, etc. Hard, wet floors increase the chance of hoof injuries. Wherever possible, the amount of time that cattle spend standing or walking on concrete floors should be minimized. Rubber mats placed in front of feed bunks increase the time that cattle spend at the feeder and reduce the time they stand in their stalls (Fregonesi et al., 2004; Tucker et al., 2006). Flooring in walking areas should provide adequate traction. Hard rubber mats should be sufficiently grooved or textured to allow the feet to grip even when wet. If concrete is used, it should be grooved, and must not have sharp protrusions that will damage the hooves of the cows. Good drainage of flooring is essential: standing in chronically wet conditions damages the interdigital skin and heel of the hoof and increases the risk of hoof disease, and reduces the hardness of the hoof (Borderas et al., 2004).

Use of slatted floors exclusively requires careful monitoring of air quality, especially when manure spends more than 12 hours under the slats. Slatted floors may also increase the risk of hoof and leg damage (e.g., Hinterhofer et al., 2006) unless alternative laying areas are provided to the cattle. Alternative flooring materials that are less traumatic than concrete should be used if slatted flooring is essential. Otherwise, it is recommended that other methods of housing and manure/feces removal be explored.

#### 10.2.1.4 Environmental control

Cattle have an excellent tolerance of low temperatures, as long as ample feed is supplied. However, newborn and milk-fed calves can be adversely affected by cold, and when calving occurs in cold weather, the new born calves should be provided with draft-free shelters and dry bedding.

Cattle are sensitive to heat stress. Heat stress can begin to occur when temperatures rise above 25°C. This is particularly true of milk-fed veal calves that generate considerable metabolic heat. An increased and laboured respiration rate is a sign of heat stress. Cattle must be provided with protection against heat. Cattle housed indoors should be provided with adequate ventilation to reduce heat load. Heat stress in feedlot cattle will be increased by high ambient temperature, high relative humidity and low wind speed. In feedlot locations where ambient temperature is likely to exceed 29°C, relative humidity is greater than 60% and wind speed less than 4 m/second, black cattle should not be chosen for study as they are most prone to heat stress (Mader et al., 2006).

Indoor cattle facilities should be fitted with equipment for monitoring temperature and humidity, and appropriate means should be available to deal with extra heat loads (e.g., extra fans or ventilation, and water sprinklers). Sprinklers should not be used when humidity is high.

Sufficient lighting should be provided so that all animals can be inspected properly at all times. Between 8 and 18 hours of lighting per 24 hours is suggested.

Feedlot pens should be illuminated at night to promote calm animals. Lighting intensity at night should be 10 lux along the bunk, and 2.5 lux at the back of the pen (Winchell et al., 2000). Use of lights with automatic photo-electric cells is recommended to ensure illumination when required.

## 10.2.2 Acquisition, transport and quarantine

Transporting cattle should be done in accordance with the *Recommended code of practice for the care and handling of farm animals – Transportation* (http://www.nfacc.ca/code.aspx). Staff should receive training in the requirements of facility design and good handling practices to facilitate the loading and unloading of all ages of cattle, and the identification of those animals which should not be transported.

Cattle should be closely inspected upon arrival to ensure their good health, and placed in quarantine facilities in accordance with established herd health protocols. In particular, cattle should be under frequent veterinary inspection until a suitable quarantine period has passed. Appropriate remedial measures should be taken for those animals which arrive at the experimental facilities injured or otherwise in ill health.

**Guideline 80:**

**Where possible, only preconditioned beef cattle should be purchased.**

Horned cattle should not be purchased. Purchasing pre-conditioned cattle (weaned, castrated, de-horned, vaccinated at least 30 days prior to sale and having prior feed bunk experience) is recommended to reduce animal stress and ensure efficacy of vaccination. Pre-conditioned calves should not be mixed with unconditioned calves. Feedlot animals should be processed on entry to the feedlot if necessary, including vaccination, implanting, de-horning or castration. If processing cannot take place on arrival, calves should be allowed at least 2 weeks to acclimatize to their new surroundings before processing, to avoid a severe outbreak of respiratory disease.

**Guideline 81:**

**Where possible, polled beef cattle should be used.**

Dehorning cattle at entry to the feedlot is stressful and has a long-lasting negative impact on animal performance. Goonewardene & Hand (1991) found that steers dehorned at the feedlot had significantly lower growth rates compared to polled animals over the first 106 days of the feeding period.

## 10.2.3 Husbandry

### 10.2.3.1 Housing and animal management

#### Managing cattle kept in feedlots

Feedlot management should be all-in-all-out. Mixing and sorting of animals among pens is stressful and promotes transmission of disease (Stanford et al., 2005).

#### Managing housing for bulls

Bulls can be dangerous; they are unpredictable and may be aggressive to humans and other bulls. When working with bulls, extreme caution is advised, particularly in confined situations. New bulls should not be introduced to an existing pen of bulls as injury, especially to the new animals, is likely from fighting to determine dominance.

### 10.2.3.2 Feed and water

Beef cattle are often fed grain-based diets to increase growth rates. Such diets can lead to acidosis, liver abscesses and laminitis. A gradual transition from forage-based to grain-based diets is essential to minimize the risks of such health problems. Maintaining 15% of dry matter intake as forage will help reduce problems with ruminal acidosis.

Cattle generate considerable metabolic heat, which can increase heat load during hot weather. Rations should be manipulated to reduce heat stress.

Vertical (sand) cracks in the hooves of pastured cattle may be a sign of vitamin or mineral deficiency or other nutritional problem (Hand et al., 1992). Intervention such as hoof trimming or culling of animals may be required, as a year of nutritional supplementation may be necessary for complete repair of the hoof. Overweight cattle are more susceptible to sand cracks, and a predisposition to sand cracks has been genetically linked.

Cattle drink prodigious quantities of water and should have *ad libitum* access to clean water. Water requirements for beef cattle are 32-45 L/animal/day, depending on weather.

Drinkers must be checked daily to ensure animals always have access to water and the water remains ice-free. Water bowls should be cleaned routinely to ensure adequate water intake and reduce transmission of pathogens. Individual or group drinkers must be cleaned weekly, or more often if they get contaminated.

*Nutrient Requirements of Beef Cattle*, developed by the National Research Council (2000), should be viewed as minimum requirements.

### Calves

An adequate intake of colostrum is essential to ensure that new born calves have sufficient immunological protection. An inadequate colostrum intake will increase the risk of pre-weaning mortality and morbidity. A minimum serum concentration of 10mg/ml of IgG indicates successful passive transfer of immunity. To achieve this, calves should ingest at least 6 L of good quality colostrum during the first 24 hours after birth, and preferably within the first 6 hours.

Colostrum can be collected and frozen from cows in the herd with an abundant supply to better match antibody requirements of calves at the research site. Frozen colostrum should be used or discarded within a 1-year period

To avoid white muscle disease in young calves, pregnant cows should be injected with vitamin E/selenium at least 1 month prior to the expected calving date. In severely deficient areas, additional selenium supplementation to calves may be necessary.

Newly weaned calves should receive familiar diets for the first 7 days to avoid compounding weaning stress with dietary change.

Two-stage weaning (i.e. suppression of milk provision before separation from the dam) has been shown to be less stressful for cows and calves than abrupt separation, and should be employed (Haley et al., 2005).

When cattle are fed at less than *ad libitum* intake, such as winter feeding beef cows or starting newly-weaned calves on feed, there must be sufficient bunk space and feed delivery such that all animals have room to eat at the same time.

To avoid negative health effects of grain-based diets, animals first entering the feedlot should receive diets of 60-70% forage and 30-40% cereal grain for the first 7 to10 days. If no digestive disturbances are noted, roughage can be decreased by 10% every 2 to 4 days until the diet contains 10-20% forage (McAllister et al., 2000). Changes in weather or forage quality may affect intake and will extend the required period for adaptation to a high grain diet.

### 10.2.3.3 Bedding

Cattle should not lie on bare concrete floors. Floors that are too hard increase the incidence of tail injuries, swollen knees and hock abrasions (Weary & Taszkun, 2000).

Deep straw or sawdust is the most common form of bedding used for cattle. Straw is preferable to sawdust, and if sawdust is used it should be cleaned regularly to ensure a dry bedding area.

### 10.2.3.4 Environmental improvement

Free-standing grooming devices, also known as scratchers, are commercially available, frequently used by feedlot cattle, and are recommended to improve animal comfort.

### 10.2.3.5 Human contact and handling

**Guideline 82:**

**Employees responsible for handling cattle should receive instruction in low-stress methods of handling.**

Rough handling has been shown to be a source of stress for cattle of all ages. Cattle recognize individual people and become frightened of people who handle them roughly. Cattle can also become frightened of the places where they have been handled roughly. Aversive (painful or frightening) handling, such as tail twisting, shouting and hitting, is unacceptable.

Guideline 83:

**The electric prod must not be used in routine handling.**

Striking instruments and electric prods should never be necessary for moving animals. Aids for moving animals such as panels, flags, plastic paddles, flappers (a length of cane with a short strap of leather or canvas attached), plastic bags and metallic rattles should be used for this purpose. Objects such as sticks, metal piping, fencing wire or heavy leather belts should not be used. Shouting, yelling at animals or making loud noises (e.g., through the cracking of whips to encourage them to move) should not occur, as such actions may agitate the animals and lead to crowding or falling. In rare and extreme situations, the use of cattle prods may be required for the animal's own welfare. Electric prods must never be used on sensitive body parts such as the face, anus and reproductive organs.

Beef cattle raised with limited human contact are often afraid of people, highly excitable and unpredictable. Handling facilities should be properly designed so as to reduce stress to the animals and the risk of injury to both handlers and animals. Recommendations for commercial facilities should be followed (Grandin, 1997, 2000).

When entering a pen of feedlot cattle, movements should be slow and deliberate to avoid startling the cattle and causing them to stampede.

Beef cows with young calves are often highly protective of their calves and may react aggressively if their calf is approached. Handlers of these animals should use caution, have planned escape routes, and carry a stock stick for personal protection.

If an individual animal that is to be removed from a feedlot pen or pasture is excessively fearful, isolation of this animal should be avoided. Instead, the target animal and one or two calmer companions, which can later be returned to the pen or pasture, should be removed.

When handling mature bulls, research staff must use extreme caution and never work alone. Bulls are unpredictable and may behave aggressively to humans and other bulls.

### 10.2.3.6 Restraint

Restraint periods should be minimized in order to reduce stress levels for the animals. Handlers should remain calm throughout the restraint process and use good animal handling practices.

Equipment for restraining cattle should be properly designed and well maintained to avoid injury to animals and staff. Non-slip flooring and good lighting will encourage animals to enter races and squeeze chutes. Head gates should be designed so that cattle will not choke if they go down in the chute.

### 10.2.3.7 Routine husbandry practices

Routine procedures such as artificial insemination and rectal palpation for pregnancy diagnosis are not considered invasive in the context of this guidelines document. However, these should be carried out only by trained and competent individuals, to ensure that the impact on the animals is minimized.

Bulls undergoing routine semen collection should be trained to mount a mechanical dummy cow, as electro-ejaculation is stressful. Electro-ejaculation should only be conducted by experienced staff members, and used when training bulls to mount is not practical, such as for large-scale individual testing. Equipment used for electro-ejaculation should be well maintained. Improper probe positioning or excessive duration of electro-ejaculation may lead to temporary paralysis, loss of muscle control and animal injury.

### 10.2.3.8 Routine invasive agricultural practices

#### Castration

Guideline 84:

**Anesthetics and analgesics should be used for castrating cattle.**

Traditionally, calves are castrated to control breeding and reduce aggressive behaviours. Three methods are used: 1) rubber ring, which can only be used up to 7 days of age and restricts the flow of blood to the scrotum; 2) bloodless castration by crushing the spermatic cords (burdizzo); and 3) surgical castration. Large bands must not be used to castrate animals less than 7 days of age.

Irrespective of the age of the calf, all three methods of castration cause pain, as assessed by cortisol and behavioural responses. Surgical castration is the most effective method (Kent et al., 1996) but is also the most painful (Robertson et al., 1994; Molony et al., 1995; Fisher et al., 1996; Fisher et al., 2001; Stafford & Mellor, 2005b). The burdizzo (which crushes the testicular cords, nerves and blood vessels in the neck of the scrotum) results in fewer complications at the site of castration and the lowest overall response to acute pain (Goonewardene & Hand, 1991; Fisher et al., 1996; Kent et al., 1996). However, there is a significant failure rate with the burdizzo (Kent et al., 1996) and it is difficult to perform effectively in older calves. Use of rubber rings shortly after birth likely causes the least acute pain, but cortisol levels and behavioural observations indicate that it is stressful for a much longer time than surgical or burdizzo castration (Robertson et al., 1994; Molony et al., 1995; Thuer et al., 2005). Other than not including both testicles in the band, rubber band castration is the least likely to fail or have medical complications provided that tetanus prophylaxis is used routinely in the herd. Local anaesthetics may reduce pain responses during the operation but do not provide adequate post-operative pain relief since many local anaesthetics are effective for only 2 to 3 hours after administration (Fisher et al., 1996). Use of non-steroidal anti-inflammatory drugs can reduce pain more effectively and for a longer period of time than local anesthetic (Earley & Crowe, 2002).

## Dehorning

Horns are removed from cattle in order to minimize the risk of injury both to animals and to their handlers. Polled cattle exist in several breeds, show similar production to cattle with horns (Goonewardene et al., 1999), and should be used unless research requires the use of horned breeds of cattle.

**Guideline 85:**

**Adult cattle should not undergo dehorning procedures.**

Dehorning is extremely stressful, leading to growth setbacks lasting over 100 days (Goonewardene & Hand, 1991).

Horns should be removed before 3 months of age. Young animals can be disbudded to prevent growth of horns, but once the horns are well established, dehorning is the only option. For calves less than 2 months of age, use of a heated disbudding iron applied over the horn buds produces levels of plasma cortisol equal to using a dehorning scoop (Wohlt et al., 1994). Once the horns are fully vascularized, dehorning requires cutting with a saw or cutting wire, and the exposed blood vessels must be cauterized to prevent hemorrhage. Horn shears must not be used as they can cause significant blood loss.

**Guideline 86:**

**Disbudding and dehorning are painful and stressful procedures, and effective pain control methods must be used.**

Local anaesthetics can reduce pain responses during hot-iron dehorning, but do not provide adequate post-operative pain relief since many local anaesthetics are effective for only 2 to 3 hours after administration. Use of non-steroidal anti-inflammatory drugs such as ketoprofen (licensed for cattle and horses only), in addition to a local anaesthetic, can reduce pain for a longer period of time. In addition, calves being dehorned require restraint, which can be stressful; use of a sedative (such as xylazine) can essentially eliminate the need for physical restraint (McMeekan et al., 1998; Faulkner & Weary, 2000; Vickers et al., 2005).

## Cattle identification

### *Branding*

**Guideline 87:**

**Cattle should not be branded. Where branding is essential or required by law for identification, then only one brand should be used.**

Hot-iron branding is a very painful procedure (Schwartzkopf-Genswein et al., 1997b), and should be phased out. Alternative means of identifying cattle should be used whenever possible. Freeze branding is also painful, but less so than hot-iron branding (Schwartzkopf-Genswein et al., 1997a,b). If hot-iron branding is unavoidable, it should be done as quickly as possible, using as few brands as possible. Composite brands should not be used. A method of pain control (e.g., anti-inflammatories and/or analgesics) should be used. Cattle must not be branded on the face.

#### *Tagging*

Ear tags must be inserted carefully to avoid infection and further injury. Infections or injuries at the site of tags should be treated. An excessive number of ear tags (>1 per ear) should be avoided by using only tags required by the Canadian Cattle Identification Agency.

### 10.2.3.9 Parturition and caring for young

Pregnant cows maintained in confined facilities should be closely monitored during the final weeks before calving, and introduced to the calving area at least 3 days before the expected calving date.

For information on facilities for housing calves, see section 10.2.1.1 Engineering and design. Information on feed and water for calves is provided in Section 10.2.3.2.

#### Difficult births and caesarian section

Caesarian sections should normally be performed by a veterinarian, and with the use of appropriate anesthesia and post-operative analgesia.

When using mechanical calf-pulling devices, care should be taken not to apply excessive force that may result in impaired mobility of the calf due to ligament or nerve damage, and soft tissue damage to the cow which will result in bruising, infection and possibly nerve damage. Use of mechanical calf-pulling devices should be used only when necessary and by properly trained and experienced staff.

### 10.2.3.10 Heath and disease control

**Guideline 88:**

**A program of preventive health care should be established in consultation with a veterinarian.**

Accurate records of individual animals treated for disease should be maintained and monitored daily to detect trends and avoid further outbreaks of disease.

Neonatal beef calves in confined facilities should be monitored at least once daily for symptoms of malnutrition/poor mothering and diseases such as scours and pneumonia.

On entry to the feedlot, cattle should be vaccinated for infectious bovine rhinotracheitis (IBR), bovine virus diarrhea (BVD), and parainfluenza-3 virus (PI3). A multi-way Clostridial vaccine should be used that contains at least the antigens of *Clostridium tetani* (tetanus), *C. septicum* (malignant edema) and *C. chauvoei* (blackleg), unless buying pre-conditioned feedlot animals (Harland, 2000).

Undifferentiated bovine respiratory disease (UBRD) is the most common disease of feedlot cattle and generally occurs within the first 21 days of entry into the feedlot, with the epidemic peak occurring 3 to 10 days after arrival. Other feedlot diseases that can cause significant morbidity and mortality include *Histophilus somni*, (previously classified as *Haemophilus somnus, see* http://www.uniprot.org/taxonomy/228400), disease complex (encephalitis, pneumonia, arthritis, myocardial abscesses), *Mycoplasma bovis* infection (arthritis, pneumonia), foot lameness (pasture footrot), laminitis, IBR, BVD (acute and persistently infected), urinary calculi and grain overload (acute severe lactic acidosis). Pens of feedlot cattle should be monitored at least twice daily by personnel trained in detection of injury or disease, with affected animals removed to small, sheltered hospital pens. A treatment protocol for affected cattle should be discussed with the herd veterinarian and instituted prior to the arrival of the cattle.

Biting flies and other insects are a source of considerable stress and discomfort in both penned and pastured cattle. On pasture, use of 'oiler' devices which release insecticidal solutions when rubbed by the cattle may provide some relief. In feedlot situations, fly populations should be monitored by use of spot cards or baited jug traps, and control measures implemented when more than 300 flies per week are caught in a baited trap (Alberta Cattle Feeders Association, 2002). Sanitation is key to fly control. Removal of manure and spoiled feed, and moisture control will eliminate developmental sites and reduce fly breeding success. Chemical applications to manure and larval developmental sites should be avoided. Instead, chemicals may be applied to fly resting sites (identifiable by presence of fly specks) or directly to the cattle. Approved insecticides are listed in Lysyk et al. (1996).

### Metabolic diseases

**Guideline 89:**

**Cattle should not be fed diets that lead to acidosis.**

Feeding management practices likely to lead to metabolic disorders should be avoided as far as possible.

Metabolic disorders may arise with both low input systems, where nutrient supply is insufficient to meet the demands of the cattle, or with higher input systems, where feeding mismanagement can lead to digestive upsets.

Feeding high-grain diets to cattle without proper acclimation and feeding management can lead to acidosis and a variety of metabolic disturbances. Fine grinding of grain and rapid changes in diet should be avoided to prevent digestive disturbances such as bloat or acidosis.

### Body condition scoring

Routine weighing or body condition scoring of cattle should be done to help detect the loss of live weight that may indicate inadequate nutrition. On a five-point scale, scores of less than 2 are indicative of severe undernourishment, while scores over 4 indicate excess feed intake (Marx, 2004). Changes in feeding patterns can also indicate metabolic disturbances.

In herds kept for teaching or research, the diet of the cattle should be formulated primarily to protect the health of the animals, and appropriate corrective factors should be given when necessary. Good health should not be sacrificed to achieve higher growth rates.

### 10.2.3.11 Disposal of animals

See general information in Section 6.11 Disposal of animals.

### Slaughter

The Ontario Farm Animal Council has developed a decision tree to assist in determining when animals are fit to be loaded for transport to slaughter facilities and when they should be euthanized on-site (http://www.ofac.org/pdf/Cattle_Chart_2007_5.pdf). Further information is provided by the CFIA at http://www.inspection.gc.ca/english/anima/trans/consensuse.shtml.

### Non-ambulatory animals or “downers”

**Guideline 90:**

**Non-ambulatory cattle must not be transported, except in certain exceptional circumstances such as for veterinary treatment.**

CFIA regulations (June 2005) dictate that non-ambulatory animals cannot be transported except for therapeutic reasons, such as to a veterinary hospital for treatment. All non-ambulatory (downer) cattle should be euthanized if veterinary examination determines that the prognosis for a speedy recovery is poor.

When movement of non-ambulatory animals is necessary, such as prior to transportation for veterinary treatment, animals should only be moved using slings or other suitable devices. Unless appropriate devices are available, non-ambulatory animals should not be moved. Non-ambulatory animals must not be dragged.

### Euthanasia

On-site euthanasia of cattle may be necessary in cases of severe injury or disease, or as a result of disasters such as fire, flood or emergency disease outbreaks. In research facilities, on-site euthanasia is also required where animals cannot be permitted to enter the food chain. In these instances, the animals must be killed in a humane manner that leads to immediate insensibility and minimizes fear and anxiety in the animal. Basic methods appropriate for on-farm euthanasia of cattle are overdose by barbiturate, and stunning by penetrating captive bolt, followed by bleed out. Gunshot may be used in exceptional circumstances where other methods are not feasible. Euthanasia must only be carried out by properly trained personnel.

## 10.2.4 Human safety

Cattle are potential carriers of zoonotic agents. Some examples include *Cryptosporidia*, *Campylobacter*, *Coxiella burnetii* and ringworm.

Personnel working with cattle should be made aware of the possibility of becoming exposed to these infectious agents, and be instructed on the means to minimize the risk of exposure.

Personnel handling cattle must receive adequate instruction in safe and low-stress handling methods.

Because of their size, cattle can cause serious injury or death to handlers. Injuries most frequently occur when cattle are frightened or when inappropriate methods of handling or restraint are applied. Personnel should not work alone in close contact with cattle. Facilities with protected escape routes are necessary, and personnel must exercise caution and appropriate vigilance. If it is not possible to have more than one person in an area, communication devices should be provided to maintain contact with fellow workers.

## 10.3. Sheep and Goats

### 10.3.1 Facilities and facility management

#### 10.3.1.1 Outdoor shelter requirements

When lambing/kidding in cold weather, newborns should be provided with shelter and bedding, protected from drafts and kept dry. Supplemental heat (heat lamp) may be required if lambing/kidding occurs at temperatures less than -10°C.

Nursing lambs/kids should be provided with an area that is clean and well-bedded (such as a creep area) and out of all drafts. On pasture, this can be achieved by using straw bales as a wind break.

Goats require shelter from rain and snow, as they may contract respiratory diseases when wet. Goats housed in outdoor pens should be provided with shelter from rain and snow, and with adequate bedding year-round.

#### 10.3.1.2 Engineering and design of indoor facilities

For animals that do not lamb or kid at pasture, a separate lambing/kidding area should be provided. Individual pens (1.2 $m^2$) should also be available for ewes and lambs after lambing. Residence time in the pen is generally 12-48 hours, but will increase for first-lambing ewes and ewes with multiple births.

Pens should be available to group house "orphaned" lambs/kids (un-weaned lambs/kids that are from higher multiple births or where ewes/does lack sufficient milk or maternal ability). The maximum group size for these animals is 12 (Heaney & Shresth, 1985). The size of the pen should be sufficient to allow each lamb/kid uninhibited access to creep feed and milk, with separate lying areas for all animals; the pen should provide 0.6-0.8 $m^2$ of space per lamb or kid.

Weaned lambs and kids may be kept in groups, with 0.8-0.9 $m^2$ per animal. Bunk space requirements are 23-30 cm/animal for polled animals, and larger for horned animals. Mature ewes in confinement with lambs require 1.4-2.3 $m^2$, depending on the number of lambs raised by the ewe. Bunk space required for mature polled ewes with lambs is 41-51 cm/animal. Limit-fed sheep should have adequate bunk space for all animals to feed at the same time. Space requirements for sheep and goats are summarized in Table 8.

Sheep in full fleece require more space in confinement than shorn animals.

All sheep and goats require a dry comfortable area for lying and space to escape from dominant animals (Kreger, 1992), as both sheep and goats will fight less dominant herd mates. Solid partitions can be used to provide areas for escape.

#### 10.3.1.3 Floors

**Guideline 91:**

**Flooring inside sheep and goat barns should provide good traction and be well drained. Wherever possible, sheep and goats should be housed on compressible floors.**

Shorn ewes should have access to flooring with low thermal conductivity (straw-bedded or wooden flooring) (Faerevik et al., 2005). Continuous housing on concrete floors should be avoided as it leads to joint problems (Radin et al., 1982).

**Table 8 Space Requirements for Sheep and Goats**

| | Space requirements | Bunk space |
|---|---|---|
| Temporary pens for kids & lambs after birth | 1.2 $m^2$ | N/A |
| Group housing for orphaned lambs/kids (max. size is 12 animals) | 0.6-0.8 $m^2$ per animal | N/A – milk fed |
| Group housing of weaned lambs & kids | 0.8-0.9 $m^2$ per animal | 23-30 cm/animal for polled animals (more for horned animals) |
| Mature ewes with lambs | 1.4-2.3 $m^2$ (dependant on the number of lambs raised by the ewe) | 41-51 cm/animal for polled ewes with lambs |

The use of slatted floors may increase air ammonia concentrations and lead to increased respiratory problems in sheep and goats. When slatted floors are used, air quality should be continuously monitored.

Grated flooring must be sized correctly for sheep and goats (Rieger et al., 1984).

#### 10.3.1.4 Environmental control

__Guideline 92:__

**Adequate ventilation must be provided for housed sheep and goats, as they are both susceptible to respiratory infections if air quality is poor.**

Maintaining full-fleeced sheep in confinement during cold temperatures will result in higher humidity and increased ventilation requirements, compared to sheared animals.

Sheep and goat facilities should be checked daily to ensure the ventilation, drinkers and feeders are operating adequately.

### 10.3.2 Acquisition, transportation and quarantine

Sheep and goats should be placed into quarantine after arrival at the research facility, in accord with established flock/herd health SOPs. These animals should be isolated from the population but not from each other.

Transportation of sheep and goats should be done in accordance with the *Recommended Codes of Practice for the Care and Handling of Farm Animals – Transportation* (CARC, 2001; http://www.nfacc.ca/code.aspx). Loading and handling facilities should be designed specifically for sheep or goats, as injuries are likely to occur if facilities designed for cattle are used.

### 10.3.3 Husbandry

Sheep and goats should be monitored at least once daily to ensure that they are in good condition and have access to appropriate bedding, water and feed.

Wool biting may be a sign of insufficient space allotment, uncomfortable environment or nutrient imbalance. When wool biting is observed, the sheep should be put out on pasture or given increased space.

#### 10.3.3.1 Housing and animal management

__Guideline 93:__

**Sheep must not be housed in isolation. Sheep and goats should be housed with**

**other members of their species (first choice) or in sight of other sheep or goats (second choice); however, sheep and goats should not be housed together.**

Isolation of animals leads to extreme stress for sheep and goats (Parrot, 1990). Sheep and goats are by nature social animals, and should be housed in visual, auditory and, preferably, physical contact with compatible conspecifics.

Isolation will compound other stressors and may compromise surgical recovery. If an experimental design requires that sheep or goats be housed in isolation, an environmental improvement plan should be developed. This could include installation of a mirror (Parrot et al., 1988), which can be placed outside the pen or crate to protect it from breakage.

Animals of varying sizes should not be penned together (other than ewes nursing lambs), as larger animals will get a disproportionate share of the feed. Polled and horned animals should not be penned together.

Housing sheep and goats together is not recommended because of the high probability that the goats may injure the sheep. Intact male sheep and female goats should never be housed together as cross-species fertilization can occur, which will result in abortion at approximately 60 days gestation.

**Guideline 94:**

**When possible, sheep and goats should have access to the outdoors and to pasture/grazing opportunities.**

Sheep in full fleece have an excellent tolerance of low temperatures as long as they receive sufficient dietary energy. However, newborns, shorn animals (<1 cm of wool), and goats in general can be adversely affected by cold.

### Managing housing for lambing/kidding

When lambing/kidding in cold weather, the newborns should be provided with shelter and bedding, protected from drafts and kept dry. Supplemental heat (heat lamp) may be required if lambing/kidding at temperatures less than -10$^{o}$C, but should only be supplied until the neonates are dry and nursing. If supplemental heat is continually provided, the lambs/kids will tend to pile under the lamp, possibly increasing the risk of pneumonia.

For animals that do not lamb or kid at pasture, a separate lambing/kidding area should be provided which includes clean bedding.

### Managing housing for ewes and lambs/does and kids

In confinement situations, removal of ewes and lambs after lambing to individual pens will prevent mis-mothering. Residence time in the pen is generally 12 to 48 hours, but will increase for first-lambing ewes and ewes with multiple births.

In cases of higher multiple births or where ewes/does lack sufficient milk or maternal ability, un-weaned lambs/kids may be “orphaned” and housed in groups of up to 12 animals (Heaney & Shresth, 1985).

Weaned lambs and kids may be kept in groups.

## 10.3.3.2 Feed and water

Diets or pastures must be sufficient for sheep and goats to meet their physiological requirements (NRC, 1985). When animals are confined in groups, sufficient bunk space must be provided for all animals to access feed simultaneously. Otherwise, dominant animals may block access to feed.

### Pregnant ewes and does

In the last trimester of pregnancy, rumen capacity may be compromised due to requirements for uterine space, especially in the case of multiple fetuses. At this time, feed must be sufficiently nutrient dense to avoid pregnancy toxaemia (twin lamb disease). Silages and low-quality forages should be avoided. Injecting ewes and does with selenium; vitamins A, D and E; and an anti-clostridial booster one month prior to parturition will prevent white muscle disease in neonates and may improve sucking reflex in lambs and kids. It will also provide neo-natal lambs with short-term immunity against clostridial diseases.

Where ultrasound is already being used for pregnancy diagnosis, it may also be used to separate single, twin and triplet-bearing animals, and to better inform feed management.

### Orphaned lambs or kids

Lambs or kids that are orphaned within 48 hours after birth should receive a minimum of 225 mL/kg live weight of colostrum from a supply of frozen ewe or doe colostrum maintained at the research unit. Nipple buckets or individual bottles may be used for feeding, with all feeding equipment sanitized daily. Frozen cow colostrum may be used in emergency situations.

Milk replacer specifically formulated for sheep should be used subsequently as cow's milk is not sufficiently nutrient dense. Kids may be fed high-quality cow milk replacer, although goat milk replacers are commercially available and preferable.

### 10.3.3.3 Bedding

Provision of clean bedding is essential to reduce transmission of disease, and must be provided. Long straw, wood chips and wood shavings may be used as bedding. Short, chaffy straw is not recommended as bedding for sheep, as it may become embedded in the fleece and make shearing more difficult. Providing straw bedding after shearing may improve animal welfare (Faerevik et al., 2005) as sheep are more susceptible to cold stress for the first week after sheering.

Pens should be cleaned of bedding at least every 3 weeks to prevent excessive ammonia build up in enclosed buildings.

Rubber mats are useful in situations where organic bedding is not practical, for example in pens housing sheep post-surgery.

### 10.3.3.4 Environmental improvement

Sheep and goats housed in metabolism crates should have direct visual contact with other sheep/goats. Where this is difficult or limited, mirrors should be provided to reduce isolation stress.

Sheep and goats are prone to respiratory diseases when confined indoors. Access to fresh air or outdoor exercise pens will reduce incidences of diseases such as pneumonias.

Sheep and goats should have means of escaping more dominant herd mates, and this can be accomplished through the inclusion of solid partitions in pens.

### 10.3.3.5 Handling

Personnel that handle sheep and goats should be instructed in low-stress, effective handling methods. Proper facilities for handling, which allow the flow of animals while never removing sheep from the line of sight of other sheep, are an important feature of low-stress handling (Franklin & Hutson, 1982). Handling that separates individual sheep from the flock is stressful (Baldock & Sibly, 1990; Cockram et al., 1994). Lighting of raceways is critical, as sheep will balk at entering dark spaces (Hitchcock & Hutson, 1979).

### 10.3.3.6 Restraint

Sheep should never be held by the wool as excessive bruising will result. Horned sheep and goats should not be held solely by the horns. Raceways of appropriate width (36-38 cm for mature ewes, 25-28 cm for lambs) and height (0.9 m) should be constructed which allow the sheep to follow each other single file to the weigh scale or restraining cradle. Restraining cradles are commonly used for trimming hooves, and should be of appropriate size relative to the sheep or goat, and designed to ensure animal safety. A shepherd's crook should not be used to catch sheep by the legs, especially the front legs.

### 10.3.3.7 Routine husbandry practices

### Shearing and crutching

**<u>Guideline 95:</u>**

**Sheep (with the exception of hair breeds) should be sheared on an annual basis. Angora goats should be sheared every 6 months.**

For pregnant ewes, shearing is best done 6-8 weeks prior to lambing. When shearing is not possible due to inclement weather or insufficient shelter, pregnant ewes should be crutched (wool removed from vulva and udder areas) to prevent lamb starvation and disease. Neonatal lambs have been observed attempting to suckle on wool tags (balls of fecal material on long fleeces) when the ewe's udder is obscured (Billings & Vince, 1987). Shearing of pregnant ewes is preferable as shorn ewes require less space in the lambing barn and are less prone to smothering their neonatal lambs. Shearing also increases feed intake of ewes and improves overall lamb health. Shearing of heavily pregnant ewes (less than 6 weeks prior to lambing) may induce lambing on the shearing floor, and is not recommended.

After shearing, sheep become more susceptible to both cold and heat stress (Dabiri et al., 1995). If shorn in the winter, sheep require protection from the wind and snow, and additional feed energy and/or bedding for at least the first week post-shearing (depending on the severity of cold exposure). If shearing is required during inclement weather and available housing does not offer sufficient protection from the environment, shearing blades that leave 1-2 cm wool cover should be used. If shorn in the summer, sheep may require access to shade to prevent sunburn.

Due to the handling required, shearing is a well-recognized stressor of sheep (Hargreaves & Hutson, 1990; Mears et al., 1999). However, failure to provide shearing is a welfare concern due to build-up of fecal material and ectoparasites. As well, a heavy fleece may impede animal mobility. Research institutions should have established SOPs for control of sheep and goat parasites, which are suitable for the level of confinement imposed and the physiological state of the animals.

To help prevent transmission of parasites/disease to young animals, young animals should be shorn first and oldest animals last. Shearing equipment should be disinfected regularly. If an animal shows signs of a transmissible disease, such as caseous lymphadenitis, shearing equipment should be thoroughly disinfected prior to use on the next animal.

### 10.3.3.8 Routine invasive agricultural practices

### Tail docking

**Guideline 96:**

**Tail docking should only be performed when absolutely necessary.**

Circumstances where tail docking is not necessary include

- sheep that will not be kept on pasture;
- ewe lambs that will not be saved as breeding stock; or
- research projects that either do not have to reflect industry standards or end before fly strike is an issue.

Tail docking may be necessary to prevent fly strike for breeds of sheep with long woolly tails. Breeding success will also be reduced in ewes with long woolly tails due to accumulation of tags (lumps of manure). Hair sheep with short, wool-less tails do not require tail docking.

When tail docking is necessary, it should be performed on animals between 2 and 14 days of age. The tail should be docked distal to the end of the tail fold. In adult ewes, the tail must cover the vulva. Complete removal of the tail (short docking) may lead to rectal prolapse and should not be performed.

For all methods of tail docking, injection of a local anesthetic into the tail can effectively reduce the associated pain (FAWC, 2008). Use of a docking iron is the preferred method for tail docking; rubber rings should not be used unless appropriate analgesia is administered. Injection of local anaesthetics subcutaneously into the tail 1-2 minutes before applying the ring or 5-10 seconds after applying the ring, or administration of an analgesic (e.g., non-steroidal anti-inflammatory drug) 20 minutes prior to application of the ring, have produced low-level cortisol responses equivalent to when a docking iron is used (Mellor & Stafford, 2000).

### Disbudding

Although many sheep breeds are naturally polled, virtually all goats of both genders have horns. For goats, disbudding is the only option where horn removal is required, as naturally polled goats may have limited fertility due to a strong genetic link between hermaphrodism (intersexuality) and polledness (Pailhoux et al., 1994).

Horned goats have an increased risk of injuring handlers and other goats. For goats on pasture, horns enable the animals to fight off predators; however, in confinement, they can lead to injury.

**Guideline 97:**

**If performed, disbudding of kids must be done with adequate analgesia, and as soon as the horn buds are palpable, provided the kid is at least 2 days of age.**

Disbudding is the early removal of the horn bud. Due to the heavy vascularization and auxiliary nerve supply of horns in goats, removal of horns should only be attempted in neonatal animals, as even with the use of anaesthesia, blood loss may be life-threatening in more mature animals. Disbudding should only be attempted on lambs and kids that are healthy and thriving.

Emergence of horn buds in goats occurs earlier in bucks and varies by breed. Northern European breeds or Lamancha kids should be disbudded at 2-7 days of age for bucklings, and 3-10 days for doelings. However, Nubian doelings may not have palpable horn buds until 30 days of age, and frequent monitoring will be necessary to ensure the kids are disbudded at the earliest stage of horn growth.

The use of disbudding irons is preferred as the application of a caustic paste requires removal of the neonate from the dam for an extended period of time to avoid transfer of the paste to the udder.

When using a disbudding iron, there must be sufficient time following use on each animal to ensure maximum heating of the iron. Prior removal of the hair from around the horn bud will improve the effectiveness of the disbudding process. Extreme care must be taken not to apply the iron for too long, as the skull of a kid is much thinner than that of a calf, and is more prone to thermal injury. If the iron is hot enough, application for 5-10 seconds may be sufficient. An appropriate local anaesthetic and analgesic must be used.

## Castration

**Guideline 98:**

**Lambs and kids must not be castrated unless the research project requires it.**

Castration should not be performed if the research project will end before sexual maturity, unless surplus lambs or kids will be sold through markets where intact males are not acceptable.

**Guideline 99:**

**Local anesthetic and analgesic must be used for castration.**

For sheep and goats, crushing the spermatic cords by use of rubber rings or burdizzo between 2-4 days after birth has been found to produce less pain and distress than surgical castration (Thornton & Waterman-Pearson, 1999). Injection of a local anaesthetic into the neck of the scrotum at the site of the ring will alleviate stress responses associated with castration using rubber rings or burdizzo (Kent et al., 1998; Sutherland et al., 1999), although crushing with a burdizzo prior to applying the ring appears to alleviate the stress response to castration (Kent et al., 2001). Use of non-steroidal anti-inflammatory drugs injected intramuscularly 20 minutes prior to application of rings or burdizzo has been shown to reduce cortisol response and abnormal postures in lambs (Molony & Kent, 1997). Local anaesthetics will not mitigate the post-surgical pain responses due to surgical castration (Thornton & Waterman-Pearson, 1999).

Personnel applying the burdizzo require appropriate training. All castration performed on an animal after 14 days of age should be done in consultation with a veterinarian, and any surgical castration should be performed by a veterinarian (FAWC, 2008).

Castration should not be performed before 2 days of age as the pain caused by the procedure could disrupt maternal bonding and result in the lambs/kids not ingesting adequate amounts of colostrum and becoming predisposed to disease (FAWC, 2008).

## Artificial insemination

Although transcervical artificial insemination is commonly used for goats, the complicated structure of the cervix requires use of laparoscopic techniques for successful artificial insemination of sheep (Gourley & Riese, 1990). Such surgical techniques, along with appropriate anesthesia, should be performed only under veterinary supervision. Transcervical techniques have been developed for artificial insemination in sheep, but may lead to tearing of tissues supporting the cervix, and are not recommended.

### Ear tagging

When tagging young animals, growth of the ear must be considered, especially when using metal 'curl lock' tags. Plastic dangle tags should be chosen in appropriate sizes for sheep or goats. Tags that are too large will result in torn ears and lost tags.

### 10.3.3.9 Health and disease control

A program of preventative health care should be established in consultation with a veterinarian, and should include quarantine periods for new animals; control of viral diseases such as orf (contagious ecthyma), caprine arthritis encephalitis (CAE) in goats, and maedi visna in sheep; and treatment regimes for external and internal parasites. Vaccination protocols for Clostridial diseases (tetanus, pulpy kidney and malignant edema) and strategies for control of diseases such as *Bacteroides nodosus* and *Fusobacterium necrophorum* (contagious ovine footrot) and caseous lymphadenitis also need to be established.

### Hoof trimming

Requirements for hoof trimming vary according to breed and whether the animals are intensively housed or pastured. Hooves should be trimmed before over-growth impairs locomotion.

### Contagious footrot

Contagious footrot of sheep and goats is a welfare issue if left untreated (Ley et al., 1994; Jelinek et al., 2001). Hoof trimming will help to diagnose the foot condition and severity, but trimming is not necessary to treat the disease. Standing animals in a 10% zinc sulphate footbath for a minimum of 20 minutes and repeated soaking within 4 days is generally sufficient to treat contagious ovine footrot. Affected pastures should be kept free of animals for a minimum of 5 days, after which treated animals can be safely returned. Animals that remain lame after the second treatment should be examined and possibly culled. Further advice should be sought from the flock veterinarian. Appropriate SOPs for control and eradication of footrot will vary slightly by location, and should be developed and implemented under veterinary supervision.

### Copper toxicity

Sheep are prone to copper toxicity, and mineral supplements must be properly formulated (no added copper) (Lewis et al., 1997). Diets should not contain more than 15 ppm copper on a dry matter basis, and less than 10 ppm is recommended if using copper-sensitive sheep such as Texel. Goats may become marginally copper deficient if fed sheep diets/mineral supplements. Grazing pastures fertilized with pig manure may also lead to copper toxicity in sheep.

### Pizzle rot and urinary calculi

Feeding excess protein to rams or wethers may lead to necrosis of the penis ('pizzle rot') and should be avoided. Urinary calculi, stones which block the flow of urine, in fed rams or wethers indicate mineral imbalance (generally an imbalance of phosphorus and calcium) and/or inadequate supply or quality of drinking water. Signs of pizzle rot include excessively dirty or stained wool in the sheath area and necrotic regions on the penis, when expressed. Signs of urinary calculi include straining at urination, dribbling urine and kicking at a distended belly.

### Body condition scoring

Adequacy of the nutritional regime may be assessed by routine weighing or subjective scoring of body condition. Small ruminants are condition scored by assessing the muscle and fat cover at the first lumbar vertebra. A score of 1 would be emaciated, and a score of 5 would be obese. For overall health, small ruminants should be maintained at body condition scores between 2 and 4 (Stanford et al., 1998). Body condition scores of sheep and goats are influenced by breed. Prolific sheep breeds, such as Rideau Arcott, Finn and Romanov, and dairy goat breeds have limited stores of subcutaneous fat, and should have an additional one point added to their condition score when using a five-point scale.

### 10.3.3.10 Disposal of animals

#### Non-ambulatory animals or "downers"

<u>**Guideline 100:**</u>

**Non-ambulatory sheep or goats must not be transported, except in certain exceptional circumstances, such as for veterinary treatment.**

CFIA regulations (June 2005) dictate that non-ambulatory animals cannot be transported except for therapeutic reasons, such as to a veterinary hospital for treatment. All non-ambulatory (downer) sheep and goats should be euthanized if veterinary examination determines that the prognosis for a speedy recovery is poor.

#### Euthanasia

Euthanasia should be performed by overdose of injectable pharmaceuticals. Captive-bolt/exsanguination and free-bullet methods are also acceptable if performed competently by trained personnel. Due to the virtual irrelevance of paravertebral arteries in the supply of blood to the brain in sheep (Lynch et al., 1992), sheep lose brain function and are dead within 15 seconds after the start of exsanguination (UFAW, 1987). Stunning or use of gunshot may confer no welfare benefits and may be a welfare hazard if not performed effectively (Lynch et al., 1992).

Due to limited disposal options for sheep mortalities, facilities should be available for incineration or mortality composting.

## 10.3.4 Human safety

Due to their relatively small size, sheep and goats rarely cause lethal injuries to humans, although rams and bucks may become more aggressive during the breeding season and require monitoring if in close proximity. Sheep may panic and flee as a group due to a perceived predation threat (Hansen et al., 2001), and large groups of panicked sheep have the potential to cause injury to personnel. When feeding sheep in troughs within a pen, sheep should be gated outside the feeding area while the feed is being delivered.

### 10.3.4.1 Zoonoses

Q-fever, caused by a rickettsial organism, *Coxiella burnettii*, is extremely contagious in the dried or aerosol state. It is a common infection in goats, and may cause abortion in sheep and goats or be asymptomatic but shed in large numbers at kidding/lambing. Goats can be persistently infected, while sheep may clear the infection but become re-infected if re-exposed. Humans can become infected by assisting dystocias or inhaling contaminated dust. Cats are also carriers, and barn cats may abort and serve as another source of infection. Generally, Q-fever produces flu-like symptoms in people that can last for a few days with spontaneous recovery or last several weeks and become debilitating. Q-fever has several syndromes including an atypical pneumonia, endocarditis and hepatitis. Very old or otherwise immune-compromised people are more likely to develop severe disease, although healthy people can also become very ill. Rapid diagnosis of Q-fever and prompt treatment will generally prevent mortality even for high-risk groups. When sheep or goats are used in science, the staff should be aware of the risk of Q-fever, as it may affect themselves, their families and others in the research environment. Research animals should be obtained from flocks and herds that are tested annually for titres to *C. burnetti*. Research facilities should be free of reproductively active cats. The Public Health Agency of Canada's *Guidelines for Biomedical Facilities using Sheep as Research Animals* should be consulted (http://www.phac-aspc.gc.ca/ols-bsl/animres-eng.php).

Orf (contagious ecthyma, sore mouth) is a viral skin condition of small ruminants which produces scabs or sores on the mouth, between toes, on the coronary band of the foot, or on the udder/teats of lactating animals (Gates, 1990). Protective gloves should be worn when handling infected animals. Orf is highly contagious and the virus can survive for decades. Water and disinfectant soap will kill the virus.

*Chlamydophila abortus* infection is a common cause of abortion in small ruminants in some areas of Canada. It is zoonotic and reports exist of pregnant women becoming ill and aborting after contracting the disease while assisting at lambing.

Listeriosis may lead to abortion, fetal death, severe illness or death of the newborn in small ruminants and humans. Infection in sheep and goats is often linked to consumption of spoiled silage. A key sign in sheep is circling due to encephalitis. Pregnant research staff should avoid exposure to sheep, goats and their environment if this pathogen is present.

Female research staff should be informed of the risk of small ruminant abortion diseases, and should be provided with options for protection from exposure, including work sites away from sheep and goats. Pregnant research staff should avoid lambing ewes or does, aborted fetuses, placentas and birth fluids unless the flock is known to be at low risk for *C. abortus*, *C. burnettii*, and *Campylobacter jejuni* or *C. fetus* infection.

### 10.3.5 Particular considerations in biomedical research

The wooly coat of the sheep which insulates so well when the sheep is living outdoors in -20ºC weather is problematic if the sheep is relocated from a farm setting into a vivarium. In such instances, the sheep will require shearing to assist in coping with what may be a 40ºC change in temperature.

## 10.4 Pigs

### 10.4.1 Facilities and facility management

**Guideline 101:**

**Pig facilities should provide adequate ventilation; thermal comfort; adequate space allowance for separate dunging, feeding and resting areas; age appropriate social/group interactions; environmental improvement; adequate feed; good quality water; and measures to protect pigs from diseases.**

#### 10.4.1.1 Engineering and design

#### Pens

Recommended space allowances for grouped pigs are given in Table 9, and can also be found in the *Recommended code of practice for care and handling of farm animals – Pigs* (AAFC, 1993). The amount of floor space required is primarily based on body size of the pigs, flooring material (i.e. totally or partially slatted, solid bedded) and environmental temperature. The amount of space should allow all pigs to lie comfortably at the same time. Space allowance in hot weather may need to be increased by 10-15% on slatted floors, or more on solid floors, to allow for heat dissipation.

Proper pen design should facilitate the pigs' preference to segregate the pen into distinct resting, feeding and dunging areas. Where pigs lie and dung is an indicator of whether the pen design satisfies their behavioural needs (Wechsler & Bachmann, 1998) and microenvironmental (e.g., temperature, air quality) needs.

Penning can be of solid or spindle construction, made from metal, concrete or plastic. It should be free of sharp surfaces likely to cause injury. Partitions should be high enough to prevent pigs from jumping out of the pen. The distance between spindles, and the distance between the lower edge of the partition and the floor, should be small enough to prevent pigs from pushing their heads or other body parts through the spaces to the point of becoming caught. Penning and all materials to which pigs have access should be free from harmful chemicals (e.g., wood preservatives) and durable, with hard, non-porous surfaces that can be cleaned and disinfected.

#### Stalls

When gestation or individual stalls are used, they must be properly drained, comfortable and clean. As noted in the *Recommended code of practice for the care and handling of farm animals – Pigs* (AAFC, 1993), stalls must be of sufficient width and length to allow the sow to

- stand or lie without the body touching both sides of the stall or udder extending into a neighbouring stall;
- lie fully extended without impediment;
- stand without the back touching any overhead bars; and
- lie down and stand up unhindered by the stall.

The majority of sows will require a stall at least 72 cm wide (McGlone et al., 2004). Sows observed sitting for long periods of time, rather than standing, may indicate that the stalls are too narrow (Li & Gonyou, 2006).

Stall gates should allow for easy entry and exit by the sow without injury. Flooring can affect

### Table 9 Minimum Floor Area Recommendations for Swine Used in Agricultural Research and Teaching

| Stage of Production | Individually housed (per pig) ($m^2$) | Groups of pigs (per pig)[a] ($m^2$) |
|---|---|---|
| Litter and lactating sow, pen | 3.15 | ------ |
| Litter and lactating sow, sow portion of crate | 1.26 | ------ |
| Nursery, 3-27 kg body weight | 0.54 | 0.16–0.37 |
| Growing, 27-57 kg body weight | 0.90 | 0.37–0.56 |
| Finishing, 57-104 kg body weight | 1.26 | 0.56–0.97 |
| Late finishing, 105-125 kg body weight | 1.26 | 0.97–1.26 |
| Pregnant Sow | ------ | 2.3 |

Adapted from FASS (1999); AAFC (1993)[1]

a Group area allowances for growing pigs range from starting to ending body weight in each phase. The needed floor area per pig decreases as group size increases (McGlone & Newby, 1994). The data presented here are for typical group sizes from 5 to 20 pigs per pen.

For small group sizes (2 to 4 pigs), the pens should be longer than the body length of the largest pig in the pen.

1 Also refer to *Recommended code of practice for care and handling of farm animal – Pigs* (AAFC, 1993) and *Addendum: Early Weaned Pigs* (CARC, 2003) for specific recommendations on different flooring types.

hygiene, injuries to legs and feet, and performance (Kornegay & Lindemann, 1984). Solid, non-slip concrete flooring is generally preferred by sows in stalls (Phillips et al., 1996), and should be well drained so as to remain dry (e.g., 2-4% slope to the rear). Any slatted flooring to the rear of the sow should not cause lameness; this is a special concern because sows in stalls may have their rear hooves permanently on a slatted area.

### Tethering

**Guideline 102:**

**Tether systems for confining sows or boars must not be used.**

Tether systems have been conclusively demonstrated to be stressful and detrimental to the health and welfare of pregnant sows (Marchant & Broom, 1994; Barnett et al., 2001).

### Farrowing facilities

Good farrowing facilities accommodate the needs of the sow and provide comfort, warmth and protection for piglets (reviewed by Bergeron et al., 2008). Types of farrowing facilities may include

- individual pens;
- individual farrowing crates;

- pens with adjustable gates that can confine the sow, as in a farrowing crate, during the peri-parturient period and then be removed to allow the sow free movement and interaction with the piglets (e.g. convert-a-pens); or

- sow-controlled housing (Pajor et al., 1999; Pajor et al., 2002), which allows the sow to exit the nest area over a piglet-proof barrier.

Facilities that provide for greater freedom of movement (e.g., the ability to turn around freely), while offering protection and warmth to piglets, are both highly encouraged (reviewed by Arey, 1997) and preferred by sows (Phillips et al., 1992). In all cases, anti-crush bars and a creep area are necessary for at least the first week to protect the piglets from overlaying by the sow, and to provide a warm micro-environment away from the sow.

The creep area with a farrowing crate is normally a heated area beside or toward the front of the crate. Where crates are not used, the creep area consists of a corner or side of the pen which the sow cannot enter. Regardless of the design, the creep area should meet the following criteria:

- It should be warm (see Table 10, Section 10.4.3), dry and free from drafts. Appropriate warmth can be achieved by a combination of ambient temperature, radiant or floor heat, protection from drafts (e.g., by solid sides and a solid cover over the creep area), and floor insulation. Creep areas, including those that are covered, should allow for inspection of the piglets to check for signs of thermal discomfort and illness.

- The creep area should be large enough for all piglets to lie in the warmed area without simultaneously lying against the sow and risk being crushed.

- Flooring in the creep area should be comfortable, dry and safe with minimal risk of traumatic injuries to the limbs and feet of piglets. On slatted floors, slot width should be no larger than 11 mm to avoid piglets' legs from becoming trapped and claws being damaged (Council of the European Union, 2001).

- Heat from the creep should not heat the sow inadvertently, as may occur with an unduly narrow creep area located directly beside the sow's lying area.

For sows penned closely with their litters, restricting the sow's movements has the potential to reduce piglet mortality from crushing. However, farrowing crates, which prevent the sow from walking, turning around and rolling onto her side, also restrict the sow's ability to perform nesting behaviour, turn around comfortably or select a suitable micro-environment for themselves or their litter (reviewed by Arey, 1997; Bergeron et al., 2008). When housing sows in farrowing crates, the following criteria should be met:

- Crates should be long enough (from the food trough at the front to the restraining gate at the rear) for the sow to lie flat on her side without impediment.

- Crate dimensions should not prevent the sow from standing up freely from a lying position, and should allow her to stand without her back touching the top of the crate.

- Flooring beneath the sow should provide adequate traction for standing and lying manoeuvres.

- The rear gate should not interfere with piglet expulsion at farrowing or impede access by the animal attendant if intervention is required during farrowing.

- Crates should not impede piglets' access to the teats during suckling. This often requires an interior crate width of 75 cm at the height of the piglets, and horizontal bars no lower than the height of weaning-age piglets.

### Outdoor rearing

If pigs are housed outdoors, protection from sun and rain should be provided in mild weather, and an opportunity for wallowing or other means of keeping cool in hot weather. In winter, there must be protection from cold and precipitation, and enough bedding for the animals to have a warm, dry lying area. Water and feed supply systems must function properly in all weather conditions. Fencing must be safe and effective for confining pigs.

#### 10.4.1.2 Environmental control and monitoring

Pigs are sensitive to their thermal environment, and to air quality, which can affect physiology, lying behaviour and dunging patterns. Indoor confinement systems usually depend on mechanical control of temperatures and ventilation. Monitoring of humidity levels is also advisable. Control systems must be set to maintain the appropriate environment for the age and production stage of the pigs occupying each area, and must be checked daily.

Finisher hogs (>90 kg) and breeding stock (>110 kg) are particularly sensitive to high environmental temperatures because of their inability to use sweating as a cooling mechanism, and therefore they can be prone to heat stress. Allowing ample space, good air movement and cooling devices, either via drip coolers (common for sows), spray coolers (more common for grow/finish pigs) and/or a wet area in which to wallow, in addition to a dunging area, will help pigs cope with high environmental temperatures.

**Guideline 103:**

**Pig facilities should be adequately ventilated to protect the health and welfare of both the pigs and the staff.**

Air movement is a key factor influencing thermal comfort for pigs. For suckling piglets, newly weaned pigs, and sick pigs of any age, there should be no detectable draft (i.e. no air movement should be felt on the back of a wet hand). Bedding, covered areas, and small, enclosed areas (hutches) allow pigs to escape drafts in a local micro-environment. Huddling, although a natural behaviour, may indicate pigs are becoming chilled. More profound indicators of a thermal environment below their comfort zone include compromised growth ('poor-doers') and increased incidence of excessively 'hairy' pigs.

**Guideline 104:**

**Lighting of sufficient intensity to properly inspect the pigs should be provided for at least eight hours per day.**

Lighting of approximately 100 lux is required to inspect the pigs. Longer than eight hour photoperiods may be appropriate in some areas, such as farrowing rooms and breeding barns. A darker sleeping or resting environment, preferred by pigs, should be provided for at least six hours per day (Taylor et al., 2006). Red spectrum light can be used to facilitate pig inspection during dark periods without disrupting the normal biological rhythms of the pigs, such as those mediated by melatonin (McGuire et al., 1973).

#### 10.4.1.3 Floors

**Guideline 105:**

**Flooring should provide a dry, comfortable lying surface; it should allow animals to conduct their normal movements and postural changes without slipping; and it should not result in injuries.**

Flooring has important effects on the comfort and health of pigs. Concrete is the most commonly used flooring material for pigs; however, slippery concrete can result in animals slipping and falling, potentially causing leg injury and lameness. Worn concrete or damaged slats can lead to hoof injuries and harbour pathogens, and they are more difficult to clean and disinfect. The hard surface may lead to excessive wear on hooves, joints and other areas of the body, and the loss of body heat to a concrete floor can cause chilling, especially among young pigs. To improve comfort and reduce slipperiness, solid concrete should drain well (e.g., with a 2% slope), and a separate dunging area which may be slatted is recommended. Good drainage is essential for both comfort and health of all pigs.

Metal and plastic flooring products are often used, especially for sows with litters and for newly weaned pigs. In addition to being hard, these materials can become slippery and cause excessive heat loss. As well, gaps must not be so narrow as to entrap a sow's nipples, which can lead to tearing and serious injury.

Appropriately placed compressible mats with good traction can be used to improve the comfort of both sows and young pigs (Tuyttens et al., 2008), and can be particularly beneficial in hospital or 'sick' pens. Mat edges must be secured or concealed to prevent pigs from chewing on them.

Common flooring faults that may need to be corrected are as follows:

1) Non-yielding floor surface

- Confined sows, especially if they are relatively lean, may develop pressure sores on the body, often where a protruding bone presses the skin against a hard surface. Compressible materials such as straw or mats may help reduce the problem.

- Suckling piglets often develop scrapes (mechanical damage to the skin by the rough floor surface) and frictional burns (heat build-up from rapid movement of the skin on the floor) on their leg joints as a result of vigorous contact between the joints and the floor during suckling. These injuries can be reduced by providing a yielding floor surface (e.g., a compressible mat in the piglet area) which gives better grip to reduce slippage, while cushioning the point of contact between the joint and the floor. Hard rubber mats can produce injuries as severe as those seen on concrete, and should be avoided.

2) Inappropriate width between slats

- Injuries to hooves and dew claws can occur if part or all of a hoof slips into the open spaces of slatted floors. This may indicate that the opening is too wide for the size of the pigs, or that the edges of the slats have become worn, resulting in an uneven gap size.

3) Floor allows too much heat loss

- A floor that is too cold or results in too much conductive heat loss will result in pigs attempting to lie on top of each other in a huddle (piling), or lying with their legs tucked beneath their bodies to minimize body contact with the floor. This problem can be reduced by insulating the floor with straw or other appropriate bedding material or compressible mats, or by increasing ambient or radiant heat. Installing floor heat in new or retrofitted facilities can be particularly useful for sows in stalls and for weanling pigs in the first few weeks in the nursery. Comfortable pigs will lie down along pen walls or next to penmates without huddling or panting.

4) Floor is too slippery for sure-footing

- Mature sows in stalls often have difficulty standing up and lying down with ease if the floor surface is slippery, or even if it is different from the flooring to which they are accustomed. Often this is evidenced by the sows spending noticeable amounts of time in a sitting position. Normally, sows sit only for a few seconds when standing up from a lying position, but if they cannot stand easily, they may remain in a sitting position for many minutes at a time. Similarly, sows that are unsure of their footing on the flooring material may take several minutes and repeated attempts to lie down, and may then lie down in a rapid, uncontrolled manner. This may be a temporary problem while they are becoming accustomed to a new type of flooring, for example in the farrowing area. If the problem persists, it suggests that the floor is unsuitable or that the amount of space available to the sow is impeding her from going through normal postural changes.

Alternative facilities, such as hoop shelters for pigs (Connor, 1997; Connor et al., 1997), which may have earthen floors, must be situated on a well-drained site to avoid water running into the shelter. The earthen floor should be underlaid with crushed stone or sand and built-up higher than the surrounding land. The earthen floor must be covered with straw or other suitable absorbent material (e.g., wood shavings, corn stocks or marsh hay) to provide comfort for the pigs and to prevent urine from pooling on, or soaking into, the soil. Allowing the pigs to spread the bedding material themselves can provide environmental enrichment.

#### 10.4.1.4 Feeders and waterers

Appropriately designed and sized feeders allow pigs to eat without standing or lying in the feeder. A concrete slab under the feeder can be used to provide a step and prevent pigs from urinating and defecating in the feeder. Difficulty in gaining and maintaining access to the feeder may result in shorter but more frequent feeding bouts (Morrison et al., 2003). The number of feeding spaces needed per pig depends on the type of feeder. Where feed restriction is used, feeding space should permit all pigs to eat comfortably at the same time, unless the animals are protected from competition while eating.

Good quality water must be presented *ad libitum*. A nipple drinker can serve up to 15 pigs or 6 sows as long as the flow rate is appropriate; flow rates for different classes of pigs are given in the *Recommended Code of Practice for the Care and Handling of Farm Animals – Pigs* (AAFC, 1993). For newly weaned pigs, the type of drinker can influence water intake, wastage and behaviour. When provided with nipple drinkers, young pigs tend to waste significantly more water. Bowl drinkers can reduce water wastage; however, bowl design is very important to minimize water contamination and ensure adequate water intake. In young pigs, push drinkers have been found to cause the least amount of water wastage with no negative impact on water or food intake (Torrey et al., 2008).

Feed and water should be provided in a way that does not cause queuing and aggression around the dispenser. For grower-finisher pigs, this can usually be achieved by providing one appropriately located feeding space for up to 10 pigs on a dry ration, or one for up to 20 pigs with wet feeding. Depending on pig size, nipple height and flow rate, water wastage in grow-finish pigs can vary between 15 and 42% (Li et al., 2005). Water wastage is decreased when nipple drinker height is adjusted based on the size of the pig. Ideally, nipple drinkers should be placed slightly higher than the pig's nose. Providing a step beneath the nipple drinker can be an effective means of providing access to water for smaller animals, while reducing wastage.

#### 10.4.1.5 Sow housing

**Guideline 106:**

**Facilities should be designed so that sows can be housed in groups, with sufficient space allowance and environmental complexity to minimize agonistic or aberrant behaviour.**

Housing sows individually in stalls restricts the sow's ability to exercise and to interact with other pigs and features of the environment. However, group housing also poses welfare issues in relation to space allowance and level of aggression (Karlen et al., 2007). The following are recommendations for group housing systems:

- Space allowance should be at least 2.3 $m^2$ per sow (Remience et al., 2007).

- Straw or another suitable material should be provided for both sow comfort and as a means of reducing the incidence of behavioural vices and aggression.

- Higher levels of aggression can be expected in barren environments (Durrell et al., 1997). In slatted systems where use of straw is not feasible, other forms of biologically-relevant enrichment should be used (Newberry, 1995). Proper environmental enrichment in pigs sustains animal interaction, can be easy manipulated, remains novel, and is edible. As such, 'rootability', 'manipulability' and 'chewability' are important factors when designing or considering environmental enhancement or 'toys' for pigs (Bracke, 2006; Studnitz M. et al., 2007).

- Increasing environmental complexity with partitioning may be useful in reducing agonistic interactions, and provides animals with the opportunity to express their natural thigmotactic behaviour (lying along pen walls).

- Animals should be observed carefully for signs of chronic aggression such as skin lesions, lameness, timidity and/or fearfulness.

- A separate holding (hospital) pen should be available for injured or harassed sows. Hospital pens should be enriched whenever possible, and the special needs of sick or injured animals should be taken into consideration (Millman, 2007).

Where electronic sow feeders (ESFs) are used, the following practices are recommended:

- One ESF should be available for every 40 sows; depending on the design, one ESF may be capable of feeding 50-60 sows within a 24 hour cycle, but this may affect the diurnal rhythm of some sows which are forced to eat at night (Edwards, 1992).

- Feeding station design should prevent pen-mates from harassing a sow that is in the feeding stall. This includes preventing sows from entering the stall when another sow is inside, and allowing a sow to exit from the feeding station without backing out into a group of other sows.

- The ESF should be located away from the sows' lying area.

- Transponders for individual identification (e.g., RFID) must be inspected daily and adjusted regularly to prevent injury, discomfort and loss. A transponder that does not work properly will prevent a sow from being able to access the feeding stall.

- Proper training of each sow on using the ESF and monitoring for adequate feed intake are essential.

- Alternate (emergency) arrangements for feeding must be in place in case of feeder breakdown.

#### 10.4.1.6 Boar housing

Individual housing requirements for boars are given in the *Recommended Code of Practice for Care and Handling of Farm Animals – Pigs* (AAFC, 1993). In general, solid floor space in a boar pen should be a minimum of 7.2 $m^2$, well drained and bedded for thermal and lying comfort. On partially slatted floors, a boar requires a minimum of 5.6 $m^2$ with a dry lying area. Locating boars close or adjacent to the breeding area facilitates ease of movement and social interaction with sows for estrus stimulation. Provision of environmental improvement, such as 'toys' or foraging material, should be included in boar housing.

### 10.4.2 Acquisition, transportation and quarantine

Moving and transporting pigs can be a major cause of stress (reviewed by Bench et al., 2008), and can lead to significant health problems. Loading and unloading is the most stressful component (reviewed by Bench, 2007a,b), and facilities for sorting and loading pigs should be designed to facilitate easy, quick and non-stressful movement of the animals (also see Section 10.4.3.5 Human contact and handling). Pigs can suffer, and in extreme cases die, from an uncontrollable increase in body temperature; therefore, care must be taken to avoid moving or loading pigs in excessive heat, and to avoid excessive exertion from fighting and running, especially in hot weather. Walls of chutes and ramps should be solid with no slope exceeding 20º. There should be no gap between the loading point and the transport vehicle. Loading facilities that are well lit and have curved walls, rather than sharp turns, facilitate smooth movement of animals. The loading dock should be level with the transport vehicle, or, if necessary, allow a step up rather than down into the vehicle. The use of electric prods should be avoided when handling pigs, as research has drawn a link between the use of electric prods and downer pigs (Coleman et al., 2003).

Enough space should be provided to allow at least half the animals to lie down naturally in transit, e.g., between 0.36 $m^2$/100 kg pig to 0.425 $m^2$/100 kg pig (Bench, 2007b). During hot weather, loading density should be reduced by 10-25% to allow for greater ventilation between animals. Regardless of the length of transport, every effort to attenuate transport stress should be made, including the provision of water (if possible), bedding during cold environmental conditions, and proper dung removal (Bench, 2007a).

Transportation and pre-slaughter management of pigs are subject to legal requirements set out in the *Regulations* under the *Health of Animals Act* and the *Meat Inspection Act*. Other recommendations are provided in the *Recommended code of practice for the care and handling of farm animals – Transportation* (CARC, 2001). Staff should receive training in the requirements of facility design and good handling practices to facilitate the loading and unloading of all ages of pigs, and the identification of those animals which should not be transported.

Pigs of substantially different weights and ages must be penned separately for transportation to minimize in-transit fighting and injury. Cull sows must be segregated from market pigs. Cull boars must be segregated from other pigs and penned individually, unless they are with a familiar pen-mate. Special consideration should be given for animals that are very young (Lewis, 2008) or pregnant. If sick, fatigued or injured pigs must be transported (as approved by a veterinarian for care or treatment), they should be loaded and unloaded in a way that minimizes pain and distress.

### 10.4.3 Husbandry

Management of effective environmental temperatures is particularly important in conventional confinement facilities without bedding, on partially or totally slatted floors. Comfortable temperature ranges vary with the size and age of the pig (see Table 10).

The effective temperature that a pig actually feels in its micro-environment depends on many factors, including flooring type and its dryness, bedding material, humidity, air movement, group size, feed type and intake, water intake, and health status.

The thermal comfort zone generally decreases with age (i.e. weight). However, at weaning pigs require a warmer environment due to reduced nutrient intake and body heat production. At temperatures below the thermal comfort zone, pigs require the addition of bedding or supplemental heat to avoid cold stress. Increased feed allowance may be required, especially for feed-restricted breeding stock, to maintain thermal comfort. Pigs in their thermal comfort zone tend to be normally active or lie down touching one another, neither huddled nor panting.

Ambient temperatures above the thermal comfort zone are not well tolerated, except for brief periods. Pigs that are too warm lie down away from penmates, pant, and have a flushed appearance. Cooling should be provided by means such as evaporatively cooled air for growing pigs ('misters'), or a water drip for lactating sows. Misting and wallowing areas can also be effective.

Ambient temperatures below the thermal comfort zone can cause animals (especially young animals) to become chilled and susceptible to disease. Animal attendants must observe the pigs for signs of thermal discomfort, such as huddling or 'piling' to conserve heat when cold, 'hairy' pigs, and pigs that are not thriving. Other signs of an inappropriate environment and pig discomfort include dunging in the eating and sleeping area, outbreak of a disease, and

**Table 10 Guidelines for Thermal Conditions for Swine Used in Agricultural Research and Teaching**

| Type and Weight | Thermal Comfort Range[a,b] | Upper Extreme |
|---|---|---|
| Lactating sow and litter | 15-24ºC for sow; 30-32ºC for piglets in a creep area | 28ºC for sow; no practical upper limit for piglets |
| Weanlings, 5-15 kg | 26-32ºC | 35ºC |
| Nursery pigs, 15-25 kg | 18-26ºC | 35ºC |
| Growing pigs, 2-60 kg | 16-25ºC | 35ºC |
| Finishing pigs, 60-100 kg | 14-25ºC | 34ºC |
| Sow or boar, >100 kg | 10-22ºC | 32ºC |

a Based on values given by Curtis (1985, 1999), NRC (1981), Hahn (1985) and AAFC (1993) for group housed animals.

b Also refer to *Recommended Code of Practice for Care and Handling of Farm Animals –Pigs* (AAFC, 1993).

decreased feed consumption and growth. Pigs can tolerate ambient temperatures well below their thermal comfort zone as long as they are group housed with sufficient dry bedding material to maintain a comfortable micro-environment (Connor, 1997; Connor et al., 1997).

### 10.4.3.1 Housing and animal management

**Guideline 107:**

**Pigs are social animals and should be housed in age and size appropriate groups as much as possible.**

Pigs should be housed in appropriate groups, based on age, weight, gender, production stage and the temperament of the animals (Hayne & Gonyou, 2003, 2006).

Pigs can be kept in various group sizes as long as there is adequate space allowance for establishment of discrete feeding, sleeping and dunging areas; space for all pigs to lie comfortably at the same time; and no competition for feed and water (Schmolke et al., 2003; Samarakone & Gonyou, 2008). Pigs housed in large groups at restricted space allowances are more susceptible to lameness (Street & Gonyou, 2008). Introducing a new pig into an established group can lead to social pressure, aggression and injury (Stookey & Gonyou, 1994; Schmolke et al., 2004). When the need to introduce a new pig arises, groups should be reformed to contain pigs that are not familiar with each other, following all-in-all-out practices.

### Sows

Chronic aggression (fighting, head-butting, shoulder-pushing, biting, and vocalizations) can be a problem, especially if limit-fed sows are kept in small groups in undivided pens. Aggression can be reduced by grouping sows of similar size and age; providing ample space or subdivided space which allows individuals to avoid aggressive pen-mates; having ample, or protected, feeding space; and providing straw or other roughage to allow animals to perform foraging behaviour (reviewed by Marchant-Forde & Marchant-Forde, 2005). Providing bulkier diets may increase satiety and reduce feeding-related aggression (Meunier-Salaun et al., 2001), while also reducing the incidence of hunger-related behavioural vices.

Aggression is especially problematic when unacquainted sows are first grouped, (e.g., after sows are weaned). This aggression can be reduced if several sows are weaned and mixed at the same time, rather than introducing individual animals into an established group. Sows are also less agitated and less prone to fight if their piglets are removed several hours before sows are moved from the lactation environment into group housing. In an ESF system, mixing sows into large groups may result in lower levels of aggression, compared with mixing into smaller groups (e.g., 25-50). However, dynamic sow groups (sows introduced to, and removed from, the group regularly) have more sow mixing and may show more aggression (Jensen et al., 2000), as each introduction or removal upsets the established hierarchy.

Sows have been shown to recognize group-mates for at least 6 weeks after separation (Arey, 1999), and aggression can be reduced by mixing gilts that are familiar to each other (Olsson & Svendsen, 1997). Whenever possible, cohorts of sows in the same breeding and farrowing cycle should be kept together for subsequent gestation periods.

The stress of aggression immediately after breeding can affect embryo development and implantation; mixing sows either immediately after weaning or 4 weeks after breeding, when implantation is complete, reduces these negative production effects. If mixing must occur after mating, it is best done within a few days of mating or left until after 28 days. Leaving mixing until after 28 days also allows for pregnancy confirmation to be completed before sows are mixed together, rather than having to remove non-pregnant sows and disrupt the group dynamic.

### *Stalls*

**Guideline 108:**

**Sows should not be confined to gestation stalls for periods longer than 4 weeks (such as to allow time for embryos to complete implantation).**

Stalls that greatly restrict the movement of sows (i.e. too narrow) can make lying in a prone position difficult for larger animals, and contribute to lameness and injury. Stall confinement of sows also leads to decreased bone density due to inactivity (Marchant & Broom, 1996; Anil et al., 2002a,b; Boyle et al., 2002; Anil et al., 2003). See 'Stalls' in Section 10.4.1.1 for requirements that should be met. A stall width of 10.7(cm) x $BW(kg)^{0.333}$ has been shown to accommodate the behavioural needs of gestating sows (Li & Gonyou, 2006). Higher parity sows often require wider stalls than gilts.

Gestation or individual stalls can be used in conjunction with an adjoining common area for small groups (4 to 5 sows) or larger groups to move freely (e.g., free-access stalls). Sows within a group should be of similar size. The stalls can be used for complete confinement of individuals as needed; for the entire group during the first month of pregnancy in order to reduce embryo mortality; for approved research protocols; and/or for individual feeding of grouped sows.

### *Farrowing crates*

Peri-parturient sows may need to be provided with some degree of confinement to facilitate proper care of the neonates and the sow without endangering the animal attendant, and because many sows prefer to be isolated from other pigs during the peri-parturient period. However, the duration of this restraint should be kept to a minimum.

Sow welfare concerns have been associated with farrowing crates during lactation (Lawrence et al., 1994; Jarvis et al., 2002). Where possible, sows should be confined to farrowing crates only during the critical first week post-farrowing, when piglets are particularly vulnerable to crushing (English & Morrison, 1984). This will also facilitate attending to newborn piglets without endangering the stockperson if a newly farrowed sow has a tendency towards aggression. Thereafter, the sow should be able to lie down and turn around freely. New facility design should incorporate farrowing accommodation that minimizes severe restriction of sow movement beyond the first week of lactation.

Sows should normally be moved into the farrowing accommodation sufficiently prior to farrowing for them to become accustomed to the lactation ration, the new environment and the flooring. Once acclimatized, sows should show normal behaviours, including being able to stand-up and lie down comfortably without uncontrolled movements, as well as eating and drinking well by the time the piglets are born. About 4-5 days adaptation to the farrowing environment is often sufficient.

Noise (including fan noise) and human activity should be kept to a minimum in the farrowing area. Natural vocalizations of sows and piglets contribute to effective nursing, and masking these vocalizations by high levels of ambient sound can disrupt suckling behaviour (Blackshaw et al., 1996; Spinka et al., 2004). Processing of piglets (tooth-clipping, castration, etc.), which often involves brief but intense noise from the piglets, may need to be done outside the farrowing room to avoid upsetting the sows and to prevent other piglets from being injured by an agitated sow.

At farrowing, unobtrusive supervision and skillful assistance can provide animal welfare and productivity advantages. Staff assisting at farrowing should be trained to provide appropriate intervention in the following situations:

- if expulsion of the piglets has become unduly delayed;
- if a sow bites at and injures piglets, e.g., exhibits savaging behaviour (Chen et al., 2008);
- if piglets are born with a feeble gasping reflex and/or fluids aspirated into the respiratory tract; and
- if piglets fail to establish normal suckling within the first 30-60 minutes.

Newborn piglets have very limited energy reserves and are prone to chilling, even at room temperatures that humans find comfortable. Radiant heating is particularly important at this early stage, but it is often provided on only one side of the sow's lying area, and the sow may lie with the udder facing away from the heat. Because the piglets are strongly attracted to the udder for many hours after birth, they can easily spend their first hours away from the radiant heat source. Consequently, it is good practice to provide extra heat sources (often overhead radiant heat lamps) on both sides of the sow during farrowing and for a 1-2 days afterward. However, care must be taken to prevent overheating the sow from any supplemental heat source(s).

The immediate post-farrowing period is a particularly vulnerable time. Close observation of sows and litters during the first few days after farrowing is especially important to ensure good animal health and welfare, and adequate milk supply. A plan for monitoring the sow and litter, together with appropriate staff training, should be in place for prompt detection and remedial action for problems such as the following:

- Retention of a dead piglet or retention of the placenta – this may be indicated by the sow continuing to strain after the farrowing appears to be complete;

- Metritis – infection of the uterus which may be indicated by large amounts of smelly, yellow to gray discharge from the birth canal;

- Mastitis – inflammation of the mammary gland, as indicated by one or more hot, swollen sections of the udder that feel hard when palpated;

- Constipation – a common health problem in the first days after farrowing, indicated by no feces or hard, dry feces; and

- Insufficient teat space or milk supply – smaller, weaker piglets, in particular, may be unable to suckle, and without intervention will die from some combination of starvation, dehydration, chilling and crushing.

Some increase in the sow's body temperature is common at farrowing, at least for sows confined in crates, but body temperatures above 40ºC should be taken as a sign of illness and be dealt with promptly.

Because of the above conditions and others, some sows may show a general malaise and lethargy during the first 1-3 days after farrowing. In such cases, an intervention plan, developed with veterinary advice, should be used in an attempt to achieve the following:

- Sows should resume eating within 24 hours of farrowing. Offering small amounts of fresh, palatable food may help restore normal eating.

- Sows should stand and drink water within approximately 12 hours after farrowing. Failure to drink may exacerbate an existing fever and other problems. Water should be easily available to newly farrowed sows from a nipple or push drinker with a high flow rate (2 L/min), or in a clean trough or bucket. Attendants may need to actively encourage some sows to drink by making them stand up, and then offering them water from a pail or hose.

- Under hot conditions (e.g., ambient temperature above 28ºC), some form of cooling should be provided for lactating sows. This may involve drip cooling in confinement, or provision of wallows in outdoor systems.

### Piglets

Young piglets are especially vulnerable to chilling, and usually require a supplemental heat source such as a heat lamp or heat mat while in the farrowing room. Newly weaned piglets (5-8 kg) also benefit from having the choice to access a heat mat, heated solid floor area or heat lamp for the first 1-2 weeks after weaning, as their body heat production is generally lower until they adjust to solid feed intake and their new environment. In solid manure systems, bedding can increase the thermal comfort for piglets and allows them to withstand lower barn temperatures. In farrowing rooms, use of red spectrum heat lamps will provide heat for piglets without being perceived as extra photoperiod by the sow(s) (McGuire et al., 1973).

Once the piglets have reached 7-10 days of age, the risk of being crushed by the sow is relatively slight. Sows and litters can be moved to less restrictive housing at this stage, often with several sows and litters penned together. When integrated into an appropriate management system, this practice can have the following benefits:

- Piglets can mingle with other litters at an early age when fighting is less intense, thereby reducing the more severe aggression that occurs when pigs are mixed at older ages.

- It may give sows some opportunity to avoid the piglets, and perhaps help curtail the negative effect of the suckling stimulus on return to estrus.

- Mixing the sows at an early stage avoids compounding the stress of mixing unfamiliar animals with the stress of sudden separation from the litter at weaning.

Newly weaned piglets must be closely monitored to ensure thermal comfort and adequate feed intake. For piglets weaned at 3-4 weeks of age, an effective environmental temperature of 26-32ºC is recommended, with minimal fluctuation, followed by a decline of 1-2ºC per week. Preference tests in piglets have found they prefer cooler temperatures during the night and higher temperatures during the day when they are more active (Bench & Gonyou, 2007). The use of radiant heat lamps, heat pads, covers or bedding can help to compensate for lower ambient temperature and gives piglets more opportunity to create or select a comfortable micro-environment.

### Grower-finishing pigs

Grower-finishing pigs can spend 75-80% of their time resting quietly if they are comfortable and well fed. Any cause of stress or discomfort can reduce lying time, and lead to restless activity, which can be manifested by aggression, tail-biting (or other behavioural vices), indiscriminate dunging patterns, reduced growth and reduced feed conversion efficiency. When signs of restlessness or these other problems occur, staff should look for potential causes of discomfort. These may include (but are not limited to) the following:

- Over-crowding – floor space should allow all pigs to rest and lie down naturally at the same time; an increase in space of 10-15% is recommended in hot weather to allow greater dissipation of body heat.

- Drafts and uncomfortable temperatures – these can arise from ventilation problems, particularly in spring and fall; drafts cause large temperature fluctuations in the pigs' environment.

- High levels of ammonia and other noxious gases – this may be associated with ventilation problems.

- On-going competition for food or water – this can result from restricted access, such as that due to pen layout, insufficient feeder space, feeder or drinker design, or jammed feeders.

- Any failure to thrive caused by illness or dietary deficiency.

Mixing of unfamiliar pigs usually results in aggression and often some degree of injury. Death can occur in extreme cases or when pigs carry the halothane 'stress-susceptible' gene. Keeping groups intact throughout the grow-finish phase may improve overall feed-efficiency and days to market. When mixing is necessary, measures should be taken to minimize the negative impacts of any aggression. These may include introducing small groups of pigs together; pre-exposing animals by housing them in adjacent pens with non-solid partitions; mixing in large open pens or large pens with multiple divisions that provide opportunities to escape from other animals; mixing in a neutral pen rather than a home pen for either group; or mixing in a well-strawed pen. Mixing animals into large groups at weaning, or before, then subdividing these groups into smaller ones as the animals grow older is one way of mixing only once during the pig's lifetime, and will minimize aggression-related problems. See 'Sows' in Section 10.4.3.1 for mixing of sow groups.

### Boars

**<u>Guideline 109:</u>**

**Boars should not be housed in sow gestation stalls.**

Although boars are usually housed individually, they can be safely kept in pairs or small groups as long as they have been together from a young age and are not showing any aggression or adverse behaviour toward each other. Individual housing for boars should allow a minimum of 2.5 $m^2$, depending on the floor type (i.e. partial slats, solid bedded).

### 10.4.3.2 Feed and water

Pigs should be fed a ration to meet or exceed the National Research Council (1998) requirements.

Feed dispensers should be checked daily to ensure that they are functioning and free from contamination such as mouldy feed and manure.

Pigs may be floor-fed as long as the surface is dry and clean, and individual feed consumption is not limited by social competition.

Water intake affects feed intake. Good quality water should normally be presented *ad libitum*, including to suckling piglets. Drinker flow rates should be monitored regularly to ensure there are no problems with the supply system and that water flow rates are adequate. In areas where water quality is known to vary, water should be tested often enough to ensure that it is suitable for the animals (also see Section 10.4.1.4 Feeders and waterers).

### Piglets

Piglets need to consume colostrum within 12 hours of birth to obtain passive immunity. A supply of colostrum should be available (i.e. frozen or freeze-dried) and administered to any piglets that are unable to consume it naturally soon after birth.

Each piglet needs access to a functioning teat with a good milk supply. Fostering or artificial rearing of piglets in a litter may be necessary if a litter is very large or if the sow's milk supply is inadequate. Piglets establish teat preference within 24-48 hours of birth, and should fostering to another sow be necessary, this should be done within this time period. Back-fostering (an older piglet into a younger litter) should not be practiced, to avoid transmission of disease (e.g., porcine reproductive and respiratory syndrome, PRRS) from older to younger animals. Signs that piglets in a litter may need to be fostered or raised artificially with milk replacer include

- active, noisy competition for teats continuing more than 12 hours after the litter is born; and
- one or more piglets failing to establish 'ownership' of a teat and continuing to fight for teats repeatedly during suckling episodes more than 12-24 hours after birth.

Fostering larger, vigorous piglets is often more successful, as they can usually establish themselves more readily in the new litter (i.e. leaving the smaller piglets with the birth mother). When fostering is not possible, piglets can be reared on milk replacer in an appropriately controlled environment. A pen or 'piggy-deck', maintained in the farrowing room, can provide the necessary micro-environment as well as maintain proximity to the sound and smell cues associated with the sow and the other litters.

Piglets begin to show interest in solid feed around 10 days of age. Providing a small amount of highly palatable creep feed, suited to the young piglets immature digestive system, helps piglets become accustomed to solid feed intake before weaning, and can help reduce the decline in growth rate experienced in the few days following weaning.

### Weaning

**Guideline 110:**

**Piglets should be weaned at no less than 3 weeks of age.**

Weaning at less than 21 days (referred to as early weaning) is not generally recommended because of the high level of management required to maintain piglet health and welfare (Robert et al., 1999; Worobec et al., 1999). As weaning age decreases from 21 days, the piglets' adverse responses to weaning tend to be stronger and their post-weaning adjustment period longer than later weaned piglets (Worobec et al., 1999). As well, belly-nosing, sucking and chewing behaviour in early weaned piglets can cause lesions and may continue as problematic behaviour into the grow-finish stage (Bench, 2005).

Where early weaning is required for an approved research protocol, particular attention must be made to ensure all environmental and feed requirements for the early weaned piglet are met (CARC, 2003). Attentive animal care personnel are essential to facilitate the piglets' adjustment to early weaning.

Diets for weaned piglets must match the stage of maturation of the digestive system. Abrupt weaning, as is common practice, is stressful. Animal care personnel need to be particularly watchful for signs of ill-health, stress behaviour or lack of adequate feed or water consumption, and respond quickly.

Newly weaned pigs appear to be especially sensitive to water quality. Any contamination of water bowls, even by feed carried on the pigs' mouths, can reduce the acceptability of water. High levels of dissolved minerals in drinking water can contribute to enteritis in newly weaned pigs.

### Sows

Gestating sows should be fed appropriately to maintain good body condition and allow for sufficient deposition of back fat reserves for lactation. The last 3 weeks of pregnancy are particularly critical in this regard. During this time, the rate of fetal growth, mammary gland development and fat deposition on the sow must be sufficient to ensure postnatal piglet viability and sow milk production without the sow becoming over-thin.

With the concentrated diets that are widely used in pig production, some feed restriction is normally needed during pregnancy to prevent excessive weight gain, which may result in later difficulties during farrowing and lactation. While the ration fulfils their nutrient requirements, sows usually eat it very quickly and may be left feeling in a state of chronic hunger for most of the day. Sows can then become very agitated and aggressive as the next feeding time approaches, and may consume excessive amounts of water.

A sow's normal response to feed restriction would be to forage for additional feed. However, in restrictive or barren environments where foraging is impossible, elements of foraging behaviour may be performed repetitively in the form of stereotyped behaviour (e.g., bar biting and sham chewing) and/or abnormal amounts of water may be consumed. Provision of a suitable foraging substrate (e.g., straw, hay, etc.) or providing a high fibre diet can increase eating time, cause greater gut fill, and reduce the incidence of aberrant behaviour.

'Skip-a-day' feeding (the practice of restricting the intake of pregnant sows by feeding them every second day) should not be used unless abundant roughage is available, for example with sows on pasture.

Especially where sows are fed in stalls, simultaneous feeding of all animals (e.g., by drop-feeding systems) is recommended to prevent excessive excitement and the injury that occasionally results. Provision of straw or hay in a rack or area separate from the feeding area will allow hungry sows to forage, and can reduce excitement and activity.

Lactating sows should be adapted to *ad libitum* feed intake during the first week of lactation to facilitate maximum milk production. Gestation feed intake and body condition are closely associated with sow appetite during lactation. Feeding strategies should consider individual sow needs, in order to maximize milk production without the sows becoming over-thin during lactation.

Some sows fail to drink enough water during the first few days of lactation, and special provisions to encourage water intake may improve sow health, milk production and, in turn, the well-being of the piglets. Thereafter, most sows appear to consume adequate water (about 15 L/day) through *ad libitum* access to a trough or a nipple drinker delivering 1-2 L/minute. Positioning the water nipple in the farrowing crate to enable the sow to drink while lying down can increase water intake within the first few days of farrowing.

**Guideline 111:**

**Group-housed sows should be individually fed.**

Group-housed sows can be individually fed using individual stalls or via ESFs, which allow for individual monitoring of feed intake. Sows can also be kept on pasture or in straw yards with coarse feed provided daily and opportunities to forage at other times; however, protection from inclement weather must be provided.

Group floor-feeding of feed-restricted sows is not generally recommended because of the very high degree of stockperson skill and attention required to avoid chronic aggression at feeding times (Edwards, 1992), and the resulting variation in body condition and welfare. Lack of feed intake control and feeding-associated aggression are often considered one of the biggest problems with group housing, especially of limit-fed gestating sows, and a major reason gestation stalls were adopted.

Where group floor-feeding cannot be avoided, feed-associated aggression may be less problematic by grouping sows of similar size and feed requirement together; ensuring ample floor space is provided; and distributing the feed over a wide area rather than dropping it in one spot (Gonyou, 2005).

The body condition of sows must be monitored closely and any animals that are becoming fat or thin should be fed individually to attain appropriate condition. Body condition can be visually appraised using a numeric scoring system (Patience et al., 1995), or back fat depth can be monitored through ultrasound. Individuals responsible for assessing the body condition of sows should be properly trained for accuracy and consistency of scoring.

### 10.4.3.3 Bedding

Pigs housed in unheated facilities require straw or another appropriate bedding material to maintain thermal comfort. Animal care personnel must monitor pig behaviour to ensure sufficient material is available. In cold weather, unheated facilities may be more prone to elevated humidity and condensation. Therefore, daily attention should be given to maintaining adequate ventilation, without any direct draft on the pigs, and to providing sufficient bedding to absorb moisture and provide a dry lying area for the animals.

Straw bedding has several potential advantages for pigs, and should be used whenever possible (reviewed by Tuyttens, 2005):

- In terms of thermal comfort, straw provides insulation against cold air or floors; pigs can use straw to compensate for about 5ºC drop in ambient temperature.
- As a source of environmental improvement, straw provides an outlet for exploratory, foraging, rooting and chewing behaviour, thus helping to reduce tail-biting in growing pigs and stereotyped behaviour in pregnant sows.
- For limit-fed pregnant sows, straw also serves as a source of dietary fibre and gut fill.

Alternative bedding materials, such as wood shavings, mushroom compost, etc., can provide many of the same benefits as straw. However, straw better meets a range of behavioural needs if only one type of bedding substrate is to be used (Tuyttens, 2005). Other alternative bedding options include synthetic, compressible lying mats (Tuyttens et al., 2008) for gestating sows, which can increase comfort but do not have the advantages of readily manipulated materials.

Only good quality straw should be used to avoid introduction of mycotoxin moulds. Straw should not be used if there are concerns with transfer of disease through the straw (e.g., from bird or rodent droppings).

### 10.4.3.4 Environmental improvement

**Guideline 112:**

**Research and teaching facilities should provide as much environmental improvement and complexity to the pigs' environment as possible.**

In a natural environment, pigs for the most part exist in social groups in habitats which incorporate a variety of resources and afford expression of a varied behavioural repertoire. Pigs will spend a majority of their day foraging, especially by rooting in the soil, overturning stones and objects, and chewing objects in the environment. Provision should be made for pigs to exercise as many of these natural behaviours as possible. Any type of environmental improvement should be deemed effective by whether it allows for expression of natural behaviours and whether it satisfies the pigs' behavioural needs. Increasing environmental complexity should contribute to satisfying a behavioural need. Otherwise, it can lead to frustration and development of behvaioural vices and stereotypies (Mason & Latham, 2004).

Environmental improvement is important to grouped pigs to minimize boredom, behavioural vices (e.g., tail-biting) and excessive aggression. Straw or other acceptable substrates can serve this purpose and satisfy foraging behaviour needs (Krause et al., 1997; Edwards, 1998), as well as help to attenuate social competition due to feed restriction (Spoolder et al., 1993; Durrell et al., 1997; Jensen et al., 2000). In slurry-based non-strawed systems, the environment will need to be designed so as not to clog the slurry pit.

However, some slurry systems can handle a small amount of chopped straw. Hanging light chains or other sanitizable objects in the group pens are a traditional form of improvement, though they are unlikely to be as effective as straw. As a general rule, the best objects to improve the environment are destructible, remain novel (always new or changeable), can be manipulated, and contain sparsely distributed edible parts (Studnitz et al., 2007). Appropriately placed partitions increase environmental complexity and provide pigs the opportunity to express their natural thigomotactic behaviour (lying along pen walls), facilitate avoidance of agonistic encounters, and affect dunging patterns in a pen. Penmates also serve to improve the environment through social companionship and stimulation.

Young pigs (particularly early-weaned pigs) have a tendency to direct their natural oral-nasal behaviour toward the bodies of pen-mates, especially when more suitable objects are not available (Bench & Gonyou, 2006). Alternative outlets for chewing, biting, nosing and sucking should be provided; these include straw, commercially available tail chews, foam rubber matting or other fibrous materials that are safe for the pigs and comply with the Canadian Quality Assurance requirements for food safety. Hard objects such as suspended chains may be less effective as a means of improving the environment than straw. However, if straw or other forms of environmental improvement are not feasible (e.g., due to research restrictions), these can prove a reasonable option, provided that their location is changed frequently.

Housing environments that enable group-housed sows to express their natural foraging and exploratory behaviour while contributing to increased gut fill in feed-restricted gestating sows is recommended. Such environments contribute greatly to stable sow groups with minimal aggression and decreased risk of stereotypies (Bergeron & Gonyou, 1997).

Sows housed individually can present a unique challenge. The barren environment of the gestation stall can lead to sham chewing, excessive drinker pressing, bar biting, prolonged dog sitting, and aggression towards an adjacent sow. Typically, the use of gestation stalls prevents the provision of straw or sufficient bedding materials. As such, improvements to the environment should be carefully considered and designed for satisfying the oral behavioural needs and comfort of the sow as well as overall practicality. For example, small hanging chains or chewable material, secured in gestation stalls and in farrowing crates, will be used by sows instead of chewing on the bars which can result in broken teeth. Sows should not be housed in gestation stalls for periods longer than four weeks (see Section 10.4.3.1).

#### 10.4.3.5 Human contact and handling

Positive human contact is an important factor for both animal welfare and productivity. Research has provided physiological evidence of long-term stress in pigs on farms where the animals react fearfully to people (i.e. shying away or vigorous avoidance), compared to farms where pigs approach people confidently. Fear reactions are associated with reduced reproductive efficiency in sows (Andersen et al., 2006) and reduced weight gains by growing pigs (Hemsworth & Barnett, 1991). Fear is caused not only by unpleasant handling (e.g., goading, slapping), but also by handlers who approach pigs too quickly. Handlers can reduce fear reactions by moving slowly and calmly, crouching to reduce apparent body size when approaching fearful animals, and stroking or scratching animals that approach. Inconsistent handling (some unpleasant and some pleasant) can produce as much long-term stress as consistently negative handling (Hemsworth et al., 1986). Furthermore, a pig's previous handling experience (whether positive or negative) influences future attempts to handle the same animal (Hemsworth et al., 1996a; Hemsworth et al., 1996b).

**Guideline 113:**

**Employees responsible for handling pigs should receive instruction in low-stress methods of handling. The electric prod must not be used in routine handling.**

Handling animals effectively and with minimum stress is a skill acquired through training and experience. Animal care staff should receive training in lifting, moving and herding pigs. Ears and tails must not be pulled. Young piglets should not be lifted by the legs only, but supported under the torso. Older pigs should generally be moved by the use of light-weight chase boards, usually made from plastic or aluminum, which allow an attendant to walk behind the pigs and keep them moving in the right direction. Aversive (painful or frightening) handling such as shouting and hitting must not be used. Electric prods must not be used as they are aversive, increase animal stress, reduce meat quality, and may result in downer animals (Coleman et al., 2003).

Lack of predictability is a common source of stress in both animals and humans. A regular daily routine of management procedures creates predictability and allows pigs to develop their own diurnal pattern of activity.

Nose rings must not be used (Horrell et al., 2001; Bornett et al., 2003).

#### Boars

Boars, including miniature or micro-boars (mini-pigs), must be handled patiently with due respect for their tendency toward aggression. Appropriate facility design, and proper use of chase boards and gating when moving or handling boars, will help to ensure animal and worker safety.

### 10.4.3.6 Restraint

Pigs used in science may require restraint more often than those raised in commercial facilities. Animal handlers must be knowledgeable in the correct procedures for pig restraint. The two most common methods of restraint for procedures (e.g., single blood sampling in pigs larger than approximately 30 kg) include the snoutsnare and the stanchion. These methods of physical restraint usually cause an acute physiological stress response in pigs, and therefore need to be done efficiently, for the absolute minimum amount of time, and by experienced personnel. To reduce the aversiveness of the restraint procedure and the association of these aversive events with people, every effort should be made by the handlers to ensure restraint procedures are associated with positive and calm handling (Hemsworth et al., 1996a; Hemsworth et al., 1996b). Both positive and negative handling experiences can affect future handling and restraint attempts with pigs.

The use of less aversive restraint methods should be sought and used whenever possible. Restraining smaller pigs can be achieved manually or by use of a sling. The use of a restraining sling for frequent blood sampling reduces vocalizations and struggling (Panepinto et al., 1983) to the point where pigs may lie quietly or sleep during the sampling procedures. Young piglets panic easily, and should be lifted by a hand beneath the ventral surface (i.e. torso), and restrained with little or no compression to the body. Dorsal recumbency for blood sampling can be achieved manually or with the aid of a V-trough. For larger pigs, a double rail restraint system, in which the pig is partially suspended by its sternum, has been recommended for use in abattoirs (Grandin, 2000) and has potential to be adapted for appropriate restraint in research facilities.

### 10.4.3.7 Routine invasive agricultural practices

#### Teeth clipping

**Guideline 114:**

**Teeth clipping should be avoided as far as possible, and should be used only in case of serious problems of damage to the udder or piglets' skin.**

Teeth clipping is not recommended as part of routine piglet processing. Institutions should evaluate whether teeth clipping is essential based on experience with the particular genotype/herd maintained at a particular facility. Teeth clipping is stressful to the piglet (Noonan et al., 1994), and if improperly performed can result in pain and injury.

Piglets are born with the canines and third incisors fully erupted. The teeth of piglets may be blunted shortly after birth to minimize damage to the dam's udders and to other piglets in the litter. Where this is necessary, teeth should be clipped no more than half way down their initial length or the sharp tips removed by grinding (Lewis et al., 2005). Improper technique of either clipping or grinding of teeth can lead to exposed pulp cavity, hemorrhage and inflammation (Hay et al., 2004). Grinding, as long as only the tooth-tip is blunted, appears to cause less tooth cracking or injury than clipping teeth. Procedures must be conducted carefully by trained individuals, and clippers should be sharp to minimize tooth cracking. All equipment should be disinfected between litters.

## Castration

**Guideline 115:**

**Castration of piglets should be avoided wherever possible.**

Castration is carried out principally to avoid boar taint in meat, but also to reduce fighting. It is not necessary if animals are killed before maturational changes occur. Boar taint can occur when boars are slaughtered at about 90 kg or heavier. The North American market demands heavier market hogs; therefore, almost all commercial male piglets in North America are castrated within two weeks of birth. Where pigs used for scientific purposes are to be marketed through commercial chains, or the research is intended to reflect commercial pork production, they will probably need to be castrated.

**Guideline 116:**

**Analgesics should be used for castration, and anesthetics should be used whenever possible.**

Castration is a painful procedure for pigs (Taylor & Weary, 2000; Puppe et al., 2005; Moya et al., 2008). Therefore, alternatives to castration (Taylor & Weary, 2000) or the use of analgesics during castration (Hay et al., 2003) should be employed whenever possible. If castration is necessary, it should be performed after the testicles have fully descended (approximately 2 days of age) and before 14 days of age, to minimize stress in the pig. After 14 days, local or general anesthetic should be used. In any event, the tearing of tissue when the testes are removed should be avoided unless prolonged analgesia is possible (Scientific Veterinary Committee, 1997; Taylor & Weary, 2000). Use of disinfected instruments by trained personnel is essential (Muirhead & Alexander, 1997).

Mature boars must be marketed intact. Castration of these animals for marketing purposes is unacceptable because of the sustained post-operative pain and swelling that results.

## Identification

Pigs may need to be marked for permanent identification, especially those in research herds. For newborn piglets, tattooing, ear-tagging and ear-notching (clipping notches in the edge of the ears) are conventional means of identification. At this time the effect of these techniques on animal welfare is not well understood. For older pigs, only ear-tagging is acceptable. Microchip implants are suitable for pigs of all ages, but may be a concern in pigs being marketed if the chips are not retrievable. Transponders (e.g., radio frequency identification or RFID) on an ear tag or neck strap are appropriate for breeding stock, and can be used in growing pigs, for example when feed intake is being monitored. For all pigs, the least invasive method of identification should be used whenever possible. Whenever invasive means of identifying animals are utilized, every effort should be taken to mitigate the stress associated with restraint and pain. Furthermore, signs of infection, persistent pain, ear rubbing and/or chewing behaviour, as a result of tagging, tattooing, ear notching, or inserting microchips, should be monitored carefully (Sherwin, 1990; Weary et al., 2006).

## Tail-docking

**Guideline 117:**

**Tail-docking should be an exceptional procedure used only in case of serious problems.**

Tail docking is not recommended as part of routine piglet processing. However, tail-docking is often done on commercial farms within the first day of birth to reduce the risk of tail-biting later in life. Tail biting can cause serious welfare and economic problems as the result of infection, abscess development in the spine, severe pain and carcass condemnation. By removing the last third of the tail, which appears to be the least sensitive, a pig is thought to be less likely to allow its tail to be chewed to the point of injury. Although pain sensitivity in the tail appears to be limited, neuromas have been observed in the tail stump of older pigs, leading to concerns about long-term pain. Where pigs are used for scientific purposes, tail-docking may be acceptable as long as it is done within the first 24 hours of birth and the animals are to be sold commercially as feeder pigs. However, if tail-docking is considered to be necessary because of a substantial risk of tail-biting, this suggests some deficiency in management or environment later in life that needs to be resolved.

It is possible to reduce tail biting by other means. Tail biting is less likely to occur when pigs with intact tails are comfortable in their environment; provided with sufficient ventilation and water; fed an adequate diet; provided with straw or other readily manipulated materials or earth for rooting or chewing; and given adequate space allowance (Fraser & Broom, 1990; Feddes & Fraser, 1993; Moinard et al., 2003). Tail biting is an indicator of compromised welfare and an inadequate environment. Once tail biting is observed, it can be hard to eliminate and is often 'socially contagious' in a short amount of time. Five to ten minutes of quiet observation is often sufficient to determine those animals engaged in tail biting. Once identified, tail biters should be immediately removed from the pen and housed individually with appropriate environmental improvement.

### Tusk and hoof trimming

Upper and lower tusks of boars can become large, sharp and dangerous with age. Boars should be de-tusked at around six months of age under the direction of a veterinarian. If this has not been done, tusks should be trimmed as required, by trained personnel or a veterinarian, to prevent them from harming humans or other pigs. Procedures must be conducted using the appropriate administration of tranquilizer and analgesics.

Hooves of sows and boars should be trimmed as needed to allow them to walk more comfortably and to avoid injuries. Breeding stock should not be housed on plastic coated flooring for long periods of time as excessive hoof growth may occur.

### 10.4.3.8 Herd health and disease control

Ensuring appropriate biosecurity measures (see Section 4.6 Security, Access, Biosecurity and Risk Management) are followed will contribute greatly to maintenance of a stable herd health status. Such measures can include controlled access to the facility; transitional procedures to reduce the risk of diseases entering with personnel (e.g., shower-in/shower-out and footwear/outwear change); a minimum time period of no contact with other pigs or facilities prior to entering the facility; SOPs for all materials and feed entering the facility; and an appropriate vermin control program.

**Guideline 118:**

**Pigs should be inspected twice daily for signs of disease, injury or failure to thrive. Animals with such problems should receive prompt attention.**

A separate, comfortable (warm, dry, draft-free) recovery (hospital) pen should be available for sick, injured or non-thriving pigs. The behavioural needs of ill individuals differ from those of healthy penmates, and failure to accommodate the needs of these individuals may exacerbate suffering (Millman, 2007). An animal in distress because of serious injury or illness that does not respond to treatment should be killed humanely (see section 10.4.3.9). Animal care staff should receive training in recognizing signs of illness, injury and discomfort in pigs, including increased thermoregulatory activities (e.g., huddling and shivering) and sleep; reduced social exploration and appetite; altered food preferences; reduced drinking behaviour; lethargy; depression; and malaise (Millman, 2007).

New stock to be introduced should be obtained from reputable suppliers with equivalent or superior health status in order to minimize the likelihood of introducing disease that could jeopardize herd health and welfare. New stock should be isolated (for at least 3-4 weeks), monitored and retested before introduction into the general animal population.

Vaccination programs should be followed, based on herd health needs. Serology profiles should be obtained at least once a year to assist in monitoring herd health status and to identify any required changes in vaccination programs. This should be carried out in consultation with the herd veterinarian.

Within-barn traffic flow should minimize the likelihood of transmission of disease. Piglets can be particularly vulnerable and should not be in contact with material from older pigs. Precautions to avoid this contact include personnel cleaning hands and wearing sanitized footwear in farrowing and nursery rooms; cleaning common traffic areas before moving piglets; and thoroughly cleaning and disinfecting pens between groups of pigs.

Sanitation is important at all stages of pig production to minimize persistence of disease organisms in their environment. SOPs that are appropriate for the health status of the herd should be developed and followed. At a minimum, this should include emptying, cleaning, disinfecting and resting a pen before a new group of animals is moved in. On a larger scale, this all-in-all-out concept can be applied to a room or whole barn. This can be especially beneficial in preventing disease transfer between groups in a farrowing facility and between weanling groups in a nursery.

All-in-all-out use of pig accommodations (by pen, by room or by barn) helps to control disease transmission. The facilities and equipment should be thoroughly cleaned and disinfected between uses.

Indoor farrowing accommodations should be cleaned, disinfected, and allowed to dry before the sow is moved in. Outdoor facilities should be given at least several days of exposure to sunshine before the next use. It is also good practice to wash sows and treat them for internal and external parasites as necessary before moving them into the farrowing area.

Sub-therapeutic levels of antibiotics should not be used routinely in research facilities due to increased risk of microbial resistance to antibiotics. Instead, therapeutic treatment of sick animals, only, is recommended. Depending on the herd health status, sub-therapeutic antibiotic use may be, at times, warranted in the early nursery phase, but only in consultation with the herd veterinarian.

Complete post mortem should be performed on at least 25% of mortalities as well as all unexplained mortalities, and records maintained in relation to animals at risk.

### 10.4.3.9 Disposal of animals

#### Slaughter

See Section 6.11 for general information on slaughter. Further information on slaughter of pigs is provided in the *Recommended code of practice for the care and handling of farm animals – Pigs* (http://www.nfacc.ca/code.aspx).

#### Non-ambulatory animals

**Guideline 119:**

**Non-ambulatory pigs must not be loaded for transport, except in certain exceptional circumstances such as for veterinary treatment.**

Canadian Food Inspection Agency (CFIA) regulations dictate that non-ambulatory animals cannot be transported except for therapeutic reasons and with the advanced approval of a veterinarian, such as to a veterinary hospital for treatment. Non-ambulatory pigs should receive prompt veterinary attention or be euthanized immediately. Guidance on making decisions regarding responsible handling of unfit pigs can also be found in *Humane Handling & Euthanasia of Swine: Standards for the Care of Unfit Animals* (Manitoba Pork Council, 2003), available from provincial and national farm animal care councils. A decision tree to assist in determining when animals are fit to be loaded for transport has been produced by the Ontario Farm Animal Council (http://www.ofac.org/pdf/PigChart_2007_01.pdf).

#### Euthanasia

When euthanasia of a pig is necessary, only acceptable humane methods can be used. These methods vary with the size and age of the pig, as noted in the *Recommended Code of Practice for the Care and Handling of Farm Animals – Pigs* (AAFC, 1993), described in the *AVMA Guidelines on Euthanasia* (AVMA, 2007), and depicted in manual format by the Manitoba Pork Council (2003). For recommended methods, see Table 1 in Section 6.11. An overdose of barbiturate is the preferred method.

Available scientific evidence overwhelmingly suggests that stunning of pigs with anoxia induced with inert gas mixtures (i.e. nitrogen and/or argon) is the best option on animal welfare grounds (EFSA, 2004). Due to lack of purpose-built equipment, inert gases are not practical under typical commercial conditions; however, research institutions could consider the use of inert gas, particularly for small (<30 kg) pigs.

As noted in Table 1 of Section 6.11, blunt trauma may be used for piglets less than three weeks old. When it is applied, the blow must be delivered to the central skull bones with sufficient force to produce massive cerebral hemorrhage and thus immediate depression of the central nervous system, producing rapid unconsciousness. When properly applied, the animal is immediately rendered unconscious and thus insensitive to pain. Subsequently, the animal's major blood vessels should be cut, and the chest and heart opened.

### 10.4.4 Human safety

Boars and sows with litters can become unpredictable and aggressive towards people. Every precaution should be exercised when moving or working around these animals and when handling piglets, particularly if the sow is not confined to a farrowing crate. Care should be taken to handle boars and sows with litters quietly and calmly to minimize stress that might trigger fear, aggression or the perceived need to defend her young (in the case of sows). Boars and sows should always be provided with a way out or 'escape route' when being moved to another location, for the safety of both handlers and the animal in the event the animal perceives a threat. If a boar or sow charges at a handler, the handler should get out of the animal's way and let it pass. If an animal appears agitated, the handler should wait until the animal has a chance to settle down before attempting to handle it.

#### 10.4.4.1 Zoonoses

Zoonotic organisms (bacteria, fungi, parasites and viruses) which can cause disease in humans may be present in most swine herds, but most often not at levels sufficient to cause human health problems. Nonetheless, people working with pigs or biological samples from pigs should be aware of the potential zoonotic risks (Leman et al., 1991; Muirhead & Alexander, 1997) and exercise every precaution to prevent transmission.

Animal attendants need to be aware of any potential zoonoses from their herd or associated with a specific research project. Standard procedures for workers should include special attention to hygiene, particularly when in contact with pig urine or feces (especially diarrhea), mucous membranes, coughing animals and any reproductive tract discharge, including placental and aborted tissues.

## 10.5. Poultry

### 10.5.1 Facilities and facility management

**Guideline 120:**

**Poultry housing should provide each animal with good ventilation, thermal comfort, sufficient space allowance, appropriate social/group interactions, good feed, good quality water, measures to protect the birds from diseases, and environments that are sufficiently complex to permit the expression of highly motivated behaviours.**

#### 10.5.1.1 Cages

In situations where birds must be housed in cage systems, it is preferable to keep them in small groups in furnished systems that permit performance of behaviours that they are highly motivated to perform, such as nesting (Duncan & Kite, 1989; Hughes et al., 1989; Follensbee et al., 1992) and perching (Olsson & Keeling, 2000, 2002). Research institutions should provide nest boxes.

Birds should be given adequate space. Cages should provide at least 600 $cm^2$ of floor space per bird at sexual maturity, with larger birds being given more space (Hughes, 1975a,b; Mashaly et al., 1984). This capacity should be available, although the birds can be kept at a higher density when young and then split into smaller groups at a lower density as they grow. Birds that are kept in individual cages will require more floor space per bird than those kept in group cages.

Cages should provide adequate height for the birds to stand normally and move their heads without damage to the combs. Since males take up more space when they crow, males require higher cages than females.

Birds should be able to easily reach feed in the trough. Laying birds make better use of trough space if the metal rods making up the fronts of their cages are positioned horizontally, rather than vertically.

For females, cage floors should be sloped as little as possible to roll the egg away (7° slope); floors should not be sloped for males. Mesh size should be small enough that birds can stand comfortably on it, and large enough that manure does not accumulate.

Perches should have rounded edges and be large enough in diameter to prevent the toe nails from damaging the foot pad. Hard woods make better perches than soft woods. Wood should not be treated but be replaced as necessary. If multiple perches are provided, they can be placed at different heights and be of different diameters to create the opportunity to distribute pressure on the birds' claws. About 30 cm perch length per bird should be provided so that the birds can perch communally. Perches should be positioned to allow birds sufficient space to descend from the perches to the lower level.

#### 10.5.1.2 Floor pens

Space for birds reared on the floor also depends on body size, with broiler breeders requiring about 0.25 $m^2$ per bird as they approach maturity. Density can be higher than this when the birds are smaller, with the groups sub-divided to provide more space as the birds grow.

There is an advantage in having rooms of sufficient size such that commercial poultry equipment can be used. This includes ensuring that ceiling height is at least 2.5 m. Large rooms also allow for flexibility in the configuration of penning or caging, which may change depending on the research needs.

#### 10.5.1.3 Feeders and waterers

A variety of feeders are available in metal and plastic. During the brooding phase, chicks should be provided with 5 cm per chick of trough access, or 4 cm per chick if round pans are used. If any feed restriction is practiced (see Section 10.5.2.2), more feeder space will be needed to ensure that all birds have equal access.

Most commercial feeders fall into the categories of tube feeders and trough feeders. For light laying breeds, 10 cm of access per bird should be provided for a trough feeder, and up to 15 cm per bird for feed-restricted broiler breeders to ensure that all the birds can feed at once. Linear space required per bird at tube feeders is slightly less.

Water can be provided during the brooding phase in various ways. For small numbers of chicks, a large glass or plastic jar can be inverted in a plastic or metal dish made for this purpose. Automatic watering systems are often used.

### Table 11 Floor Space

| Type of housing | Floor space |
|---|---|
| Cages<br>(mature birds) | 600 $cm^2$ |
| Floor rearing<br>(mature birds) | 0.25 $m^2$ per bird |

Troughs can be used, but are difficult to keep clean and leak if not kept level. Bell drinkers can be suspended from the ceiling. Water flows over the outside of the bell and is held in an upturned rim, with the flow controlled by the weight of the water. These are difficult to keep clean, tend to leak, and are becoming less popular commercially. Drinking cups can be used, but have a tendency to collect litter. Nipples provide some advantage because the drop of water that often hangs from the nipple attracts the attention of the chicks. Adequate drinking space is important; there should be 1.5 cm per chick of water trough access, 1.3 cm per chick if pans or bells are used, 4 automatic cups per 100 chicks, or 8 automatic nipples per 100 chicks.

During the rearing phase, water can be provided by troughs, bells, automatic cups or nipples. In general, cups and nipples are more hygienic. During rearing, 6-8 cm per bird of water trough access should be allowed, or up to 75 birds per bell or 10 birds per cup or nipple. Recommendations provided by the manufacturer should be consulted for specific waterer types.

For adults, water is usually supplied to caged birds using nipples or cups. Because chickens do not compete for water, nipples or cups can be located at cage junctions so that they can be shared by 2 or 4 cages, and birds in each cage will have access to more than one water outlet. Water in floor pens can be supplied as described for the rearing phase.

#### 10.5.1.4 Floors

The floors of rooms should slope to drains, and be made of sealed concrete.

#### 10.5.1.5 Manure handling

A manure removal system should be incorporated into the design of the facility. As a rough guide, 100 light hybrid laying hens produce about 12 kg of manure per day (Nesheim et al., 1979). Disposal of waste and waste water may be governed by rules and regulations of local and provincial/territorial authorities, which must be carefully observed. It may be necessary to provide a large settling tank within the building to remove the majority of solids. Advice from engineering professionals who are familiar with local by-laws should be sought during the design phase of a new building or renovations to convert an existing building to hold chickens.

#### 10.5.1.6 Environmental control

The lights in each room should be fitted with a timer and dimmer so that the length and level of illumination can be controlled automatically. Lights may be phased in and out gradually to simulate dawn and dusk, which may be useful in aviary systems. In more complex environments, variable lighting may be advantageous, with lower lighting in the nest box area than in the feeding area to encourage laying in the appropriate area.

It must be possible to control the temperature of the room to suit the age of the birds. During the brooding phase, at least part of the area housing the chicks should be kept at 32-34°C, with a gradual reduction to 20-25°C by week 4, and then maintained around 20°C during the rearing and adult phases (see Section 10.5.2.1).

The ventilation system should have sufficient capacity to cope with local climatic conditions and maximum numbers of birds in each room. The main purpose of a ventilating system is to remove the excess heat and water vapour from the building. Removal of dust and ammonia is also important. A light hybrid, medium hybrid, and broiler breeder hen produce about 42, 47 and 58 kiloJoules (kJ) of heat per hour, respectively (Weaver, 2002a). With regard to water production, 100 light hybrid laying hens at a temperature of 27ºC produce 6.5 kg of respiratory water per hour, and 6.4 kg of fecal water per hour, giving a total production of 12.9 kg of water per hour (Weaver, 2002a). The ventilation system has to remove much of this water, and the efficiency of the system will depend on the relative humidity of the ambient air at the time. The usual formula for calculating fan capacity is to allow 0.093 $m^3$ air per minute per kg for layers and 0.078 $m^3$ air per minute per kg for broilers (Weaver, 2002b).

Poultry are particularly vulnerable to the loss of power because their environments are often completely controlled and animal density is often high. Therefore, back-up generators for poultry should be checked at least once a month.

### 10.5.2 Husbandry

#### 10.5.2.1 Housing and animal management

<u>**Guideline 121:**</u>

**As social creatures, all poultry should be housed with other members of their species where possible, or in sight of conspecifics for experiments that require individual housing.**

Birds can be reared on the floor or in cages. The decision whether to use a cage or floor rearing system will depend on the nature of the research. In any housing system, the welfare of the birds should be the primary consideration.

In a natural setting, chickens form relatively small groups, and housing in large groups, especially in a small area, may result in negative social interactions.

In Canada, commercial broilers are nearly always kept on the floor, and most commercial layers are housed in cages. Breeder birds are usually kept on the floor to facilitate natural mating. Keeping hens in cages can be challenged as severely restricting the birds' movements and expression of natural behaviours. However, a cage environment separates the bird from its excreta, and therefore is usually more hygienic. Various combinations of cage and floor housing may be used. For example, birds may be kept in community cages, brooded on the floor and kept as adults in cages, or normally kept in floor pens but housed in cages during an experiment.

### Brooding phase

Chicks may be brooded on the floor or in battery brooders. Initially, the thermoregulatory ability of the chick is poor and supplementary heat must be supplied. The temperature of the entire room may be raised to 32-34°C, or the entire room may be heated to 20-25°C with additional heat to provide areas of 32-34°C. The latter has the advantage of allowing the chicks to find the temperature at which they are most comfortable. Temperature should be gradually reduced until 20°C is reached at about 4 weeks of age.

If chicks are brooded on the floor, the extra heat may be most easily provided by a suspended electrical or gas heater. Commercial brooders operated by natural gas and other fuels are available for brooding large numbers of chicks. Electrical brooders are available as heating lamps (which provide some light and may interfere with the rest period) and dull emitter heaters (which do not emit light). The heater should be switched on 24 hours before the chicks arrive. The temperature should be verified before chick placement, and should be about 32°C at a distance of 15 cm outside the brooder canopy or reflector and 5 cm above the floor. The main guide to brooder temperature should be the behaviour of the chicks. Chicks should arrange themselves evenly in a ring below the brooder. If they are too cold, the chicks huddle directly below the brooder, and if they are too hot, they spread out as far from the brooder as possible. Uneven distribution of the chicks is an indication of drafts. A brooding lamp can provide heat for up to 100 chicks and dull emitter heaters can heat a few hundred chicks. Supplemental heat can be reduced through the brooding period by raising the height of the brooder.

For the first few days, chicks may be confined to a smaller area under the brooder using a temporary construction commonly made out of corrugated cardboard. This is typically 30-40 cm high with the ends joined to make a circle, and is discarded after a few days. The circle should be large enough to allow the chicks to find the temperature at which they are most comfortable. Some form of litter with good insulating and absorbing properties should be placed on the floor to a depth of 3-5 cm. Wood shavings are common, but many other materials can be used. If wood shavings are used, they should be from untreated wood.

In research situations, chicks may be brooded in battery brooders. Each cage of the brooder commonly contains an enclosed, heated section (with the heat being controlled by a thermostat) and an open section. Food and water are supplied from troughs on the outside of the cage. The thermostat should be adjusted to provide a temperature of about 32-34°C in the enclosed section of the brooder.

Day-old chicks should be given bright (40 lux) light for the first 2-3 days to help them find food and water, and a dark period of at least 6 hours every day, since rest is very important for young chicks (Malleau et al., 2007). After this initial period, the chicks should be put on a controlled lighting program. Laying hens and all breeding birds will be kept with short day length (commonly 8 hours of light) or decreasing day length during the brooding and growth period. Commercially, chickens are kept under very dim light to help control cannibalism. If cannibalism is not a problem, a higher level of illumination may improve the welfare of the birds.

### Rearing phase

The rearing phase follows brooding and lasts until slaughter, commonly 5-6 weeks for broilers or until sexual maturity of layers and breeders at 17-24 weeks.

Sometime before about 4 weeks of age, birds acquire the ability to thermoregulate. Once this stage is reached, room temperature should be maintained around 20°C. The extremely rapid growth and subsequent heat production may shorten the brooding period for broilers. The optimum room temperature is about 20°C, but growing birds can easily cope with a range of 18-26°C.

Given the opportunity, domestic fowl will use a perch from an early age, especially at night, suggesting that their welfare is improved by having perches available. Although perches may increase some aspects of bird welfare, they may also increase the incidence of bumble foot (an inflammatory infection of the foot pad) and keel bone deformations. On the other hand, perches decrease the incidence of toe pad hyperkeratosis when added to conventional battery cages.

### Adult phase

Birds should be moved to adult quarters at 16-18 weeks of age (depending on the strain) to allow them to adapt to their new surroundings before the first egg is produced. Adult chickens are generally housed at 20°C, but a range of 16-26°C is satisfactory. Below 16°C, chickens increase feed consumption to keep warm, and above 27°C, feed consumption may not be adequate to maintain a high level of egg production. At a temperature of about 28°C, chickens begin to encounter heat stress problems.

In general, females are kept in small groups, while males are kept individually. Hens that are expected to lay eggs (layers, breeders) require long days for maximum levels of egg production. Day length can be increased gradually until it is 14-16 hours long, or it can be increased to 14-16 hours in one step.

### 10.5.2.2 Feed and water

All birds should be able to feed at the same time, especially if feed restriction is used, and water should be available at all times. The water system should be checked twice a day.

In the first few days after hatching, extra food should be provided on trays (e.g., fibre egg flats or the lids of chick boxes) in addition to the feeders, to help chicks start to eat.

Birds should be monitored closely if the type of drinker is changed between phases; chicks that have been brooded with one type of drinker may not recognize another.

Poultry food and water must not be in contact with wild birds or their excrement.

### Restricted feeding

**Guideline 122:**

**Feed intake and weight gain of broiler breeders should be carefully monitored and adjusted as necessary.**

Broilers have undergone intense and very successful selection for rapid growth, which is likely due, at least in part, to an increase in appetite. Unfortunately, reproductive success and body weight are negatively correlated, and broiler breeders that are allowed free access to feed have very poor livability and reproductive success. The welfare aspects of restricting the feed of broiler breeders is receiving some societal attention, but the body weight of modern broiler breeders must be controlled if they are to live to maturity and produce eggs. The amount of feed provided should be controlled and provided on a schedule that may skip some days. Skip-a-day feeding results in greater flock uniformity because dominant birds reach a point of satiety and allow less dominant birds to feed. When feed restriction is used, adequate feeder space is essential to provide all birds with equal access to feed. Body weight and body weight variation within a flock must be monitored, and breeder recommendations for the growth curves of specific strains should be followed. Males and females kept in the same pen can be fed separately using restriction devices on the feeders or the birds (usually males).

In general, modern laying hens are very successful at controlling their feed intake to match their metabolic needs. However, a few strains might need to be subjected to mild restriction in order to control body weight during the growing phase.

### Forced moulting

**Guideline 123:**

**Hens must not be subjected to forced moulting procedures that deprive the birds of feed or water.**

Forced moulting is a procedure that usually involves some combination of restricting feed, water and light, and causes late-cycle hens to lose their feathers and stop laying eggs. When the hens are brought back into lay, egg production and quality approach (but do not equal) that of young hens. In Canada, forced moulting is rare because the marketing system encourages keeping hens for only one laying year. If forced moulting is considered necessary, it must not use methods that deprive the birds of feed or water.

### 10.5.2.3 Environmental improvement

Various means of improving a chicken's environment are discussed below. It should be noted that these measures may not be improving the environment as much as filling environmental deficits that the cage systems impose. Chickens, turkeys and other poultry have evolved in complex environments, but it must be remembered that artificial selection has produced birds that in some cases are best suited to the environment of selection. The choice of housing systems must be balanced by the needs of specific strains.

**Guideline 124:**

**Research institutions should attempt to house adult birds in floor pens or furnished cages.**

In North America, adult layers are usually kept in cages, although some birds are kept on floors. A careful analysis should be carried out to determine whether the type of research being conducted at an institution requires housing chickens in conventional cages. Commercial alternatives are increasing in number and could be adapted to the research establishment, either in its commercial form or as a modified scaled-down version.

Whether housed in cages or pens, the following should be considered when establishing the environment of hens:

- Hens will lay their eggs in a nest box if it is provided, and there is evidence to suggest that performance of nesting behaviour is important to the hen (Follensbee et al., 1992). A nest box allows the hen to express some nesting behaviour, and if it is provided, it should be secluded but does not need to be dark. Automatic collection of eggs is possible from many types of nest boxes. If individual nest boxes are used, a single box can be shared by 5-6 hens.

- If adult birds are provided with perches, they will use them (see Section 10.5.1.1).

- In a natural setting, foraging occupies a great deal of a chicken's time, and the opportunity to forage may increase a chicken's welfare. If chickens are kept in pens, whole grain or other material can be spread on the ground. Foraging opportunities can be provided in cages, for example by hanging a net filled with fresh vegetable material in the cage. However, this may be difficult, and if foraging behaviour is considered essential, a floor-based system should be used.

- When kept in floor pens, chickens will dust bath. This opportunity can also be provided in cage systems with trays containing sand or peat moss. However, hens may lay their eggs in the trays, and the sand or peat moss may cause mechanical difficulties. These problems may be resolved by design improvements in the equipment.

### 10.5.2.4 Hygiene

It is essential that newly hatched chicks are placed in a clean environment. This is best done using an all-in-all-out system. As each room becomes empty of birds, the room and all of the equipment in it should be thoroughly cleaned and disinfected. There may be some advantage in changing disinfectants regularly, and in allowing rooms to stand empty for some days after disinfection.

### 10.5.2.5 Biosecurity

It is important for personnel to use outer clothes and footwear that are specific to each facility, and to use disinfectant footbaths (as described in Section 5.3 Quarantine) when entering a facility. If the facility is dealing with diseases or disease-causing organisms, then more stringent precautions need to be taken (see Section 3.2.3 Facilities—Biosecurity).

Access to animal facilities should be limited. Access should be denied to anyone, including service people, who has had recent contact with poultry and has not subsequently showered and changed clothes.

### 10.5.2.6 Human contact and handling

**Guideline 125:**

**When used for research, broilers should not be carried by one leg, and must be carefully placed in crates when loaded.**

Modern broilers reach market weight at a very early age, which can put stress on the joints when birds are carried by the legs. Commercially, broilers are normally carried by one leg, but the probability of injury is reduced when handlers pick up and carry the birds by both legs. Techniques should also be used that minimize wing flapping, which is a substantial source of injury. Stability is very important for chickens, and carrying them in a stable position will reduce struggling.

### 10.5.2.7 Routine husbandry practices

#### Identification

For use in science, poultry are often identified individually by means of a band. Metal leg bands can be used and have been common in the past, but are not commonly used in research. Metal bands can be attached to the wing web of day-old chicks. Care must be taken in initial banding to ensure that no muscle tissue is pierced and that the band is not between the radius and ulna of the wing. The bands must be checked during growth of the bird, with replacement of poorly placed bands. Other banding systems, such as plastic leg bands or nylon bands placed in the wing web or the skin at the back of the neck, may provide adequate identification.

### 10.5.2.8 Routine invasive agricultural practices

#### Beak trimming

Guideline 126:

**Strains of chickens with a low tendency for feather-pecking and cannibalism should be selected where possible, to avoid the need for beak trimming.**

Guideline 127:

**Where beak trimming is required, the procedure should be performed when the chicks are less than 14 days old.**

The beaks of chickens and turkeys are often trimmed to prevent damage to cage- or penmates from cannibalistic behaviour. This has traditionally been done with a hot blade that both cuts and cauterizes the beak approximately halfway between the tip of the beak and the nares (nostrils). Beak trimming may cause acute and chronic pain (Duncan et al., 1989; Gentle et al., 1990), and is an animal welfare concern. However, it is necessary to prevent cannibalism in some lines of laying hens and under some environmental conditions if the hens are to be kept in large groups. The least pain occurs if the trimming is done at one day of age, but the beak may grow back if it is trimmed at this time. Therefore, where it is necessary, trimming should be carried out before the chicks are 14 days old, and trimming the beaks of adult birds should be avoided.

Trimming must only be carried out by trained personnel with equipment that is working properly. Improper trimming may cause excessive bleeding, allow re-growth of the beak, or cause uneven growth of the beak. Some hatcheries now have precision equipment that focuses an infrared beam on the tip of the chick's beak, and this results in the tip sloughing off after about 7-8 days. If chicks are being procured from a hatchery that has this equipment, this option for beak trimming should be taken.

#### De-toeing

Guideline 128:

**Chickens should not be de-toed, but if the procedure must be done, it must not be carried out after one day of age.**

The tip of one or more toes of male breeding chickens is sometimes cut off at the distal joint to prevent damage to the skin of females during the act of copulation. This practice is discouraged, but if performed, it must be carried out at one day of age when physical damage and bleeding are minimal.

#### Dubbing

Guideline 129:

**Combs of roosters should not be removed, but if they must be removed, the procedure must be carried out no later than one day of age.**

At one day of age, the comb of a rooster is sometimes cut off at the level of the skin using manicure scissors. At this age, the comb is poorly vascularized and can be cut off at or near the level of the scalp with no bleeding. Dubbing is used to identify males so that sexing errors in cross-breeding programs can be eliminated, or to minimize damage to the comb.

### 10.5.2.9 Flock health

Intense selection for fast growth and higher egg production has produced a group of pathological problems that are commonly lumped together under the heading of metabolic disease. These include reproductive difficulties of broiler breeders (Mench, 2002) and leg problems, cardiovascular diseases, sudden acute death syndrome and ascites of broilers (Julian, 1995). Some of these can be controlled through management techniques (e.g., restricted feeding and lighting) that reduce growth rate. Among layers, selection for egg production and feed efficiency has produced hens that often have poor bone strength (Julian, 1995), especially late in the production cycle, resulting in significant welfare concerns during production, depopulation and transport. Breeding companies have added traits related to metabolic diseases to their selection programs and have had some success, but animal care attendants should be aware of these particular weaknesses and be vigilant for others that may arise with continued selection, so that their effect on animal welfare can be minimized.

Nearly all commercial chickens receive at least some vaccines to prevent disease. A variety of methods of vaccination are used depending on the vaccine, and manufacturer's instructions and veterinarian advice must be followed. Vaccines administered by spray or through the water are least invasive and require the least labour.

Feed may be medicated with a coccidiostat to prevent coccidiosis in birds kept in pens with access to their excreta. Coccidiosis can often be controlled by allowing birds to build up natural immunity and by maintaining good litter quality. If birds are kept in cages without access to their excreta, coccidiosis is not a problem. Where medicated feeds are used, withdrawal times should be observed.

Antibiotics are commonly added to poultry feeds at sub-therapeutic levels because they improve growth and feed conversion (Cardona & Cutler, 2002). This practice has been associated with development of bacterial resistance to antibiotics and is banned in some countries. Use of antibiotics at sub-therapeutic levels should be avoided. Antibiotics are also used at therapeutic levels to treat clinical disease. Some antibiotics require withdrawal times before slaughter of the birds for human consumption. If antibiotics are used and the poultry products will be used for human consumption, investigators should verify withdrawal periods with a veterinarian.

### 10.5.2.10 Disposal of animals

#### Slaughter

See Section 6.11 for general information on slaughter. Further information on slaughter of poultry is provided in the *Recommended code of practice for the care and handling of farm animals – Chickens, Turkeys and Breeders from Hatchery to Processing Plant* (http://www.nfacc.ca/code.aspx).

#### End of lay or injured poultry

**<u>Guideline 130:</u>**

**Whenever possible, end-of-lay hens should be euthanized on site rather than transported.**

Commercial laying hens are subject to weak bones, especially near the end of the laying cycle. The value of end-of-lay hens is very low and many hens are disposed of by composting. The incidence of broken bones during depopulation and transport is high (Gregory & Wilkins, 1989; Budgell & Silversides, 2004), and euthanasia on site reduces the opportunity for bone breakage and the negative effects on the welfare of the hens.

#### Euthanasia

**<u>Guideline 131:</u>**

**Euthanasia must result in rapid and reliable loss of consciousness and death, with a minimum of handling.**

Acceptable methods of euthanasia are described in the *CCAC guidelines on: laboratory animal procedures – adopted guidance on euthanasia* (in prep.). Cervical dislocation is a good technique for euthanasia if performed by trained personnel and the number of birds is small. However, killing large numbers of birds using cervical dislocation leads to operator fatigue and inevitably to welfare concerns for both the birds and the staff. Mature roosters or turkeys may be too large and strong for effective use of cervical dislocation, and a burdizzo castrator may be used to crush the vertebrae. If a burdizzo is used, death must be confirmed.

Decapitation, while obviously disconnecting the spinal column from the brain, does not produce the massive disruption of the brain stem caused by cervical dislocation, and may allow some brain function for a few seconds afterwards.

Small numbers of birds may be killed using an intravenous injection of barbiturates.

Carbon dioxide ($CO_2$) has an anaesthetic effect at certain concentrations and birds die of anoxia, but care must be taken that $CO_2$ concentrations are appropriate to produce the anaesthetic effect and result in rapid loss of consciousness. Concentrations of $CO_2$ greater than 30% may cause pain and respiratory distress before loss of consciousness, but use of $CO_2$ might be the most appropriate method of depopulation of large numbers of birds. Gas mixtures containing argon and/or nitrogen and low levels of $O_2$ do not appear to be aversive for birds. Carbon monoxide (CO) is not recommended because of the high risk to operator safety.

Electrocution is an adequate method of euthanasia in principle, but the insulating characteristics of the feathers may reduce the effectiveness. Focusing electrocution on the head area of the bird may improve the technique.

Use of a high speed macerator may be an effective and rapid method of euthanasia if instant death can be assured for all birds.

### Emergency Killing

Large-scale euthanasia in a disease situation presents particular problems, and the advice of the Canadian Food Inspection Agency should be followed.

## 10.5.3 Human safety

The principal physical risk in handling poultry is from scratches from claws, beaks or equipment. The poultry environment is often rich in bacteria, and scratches may become infected. Gloves can be worn to prevent scratches, and common antibiotic creams should be applied if they occur. Bird handlers may need to wear ear protection if they care for large numbers of mature roosters, or a mask if conditions are dusty.

### 10.5.3.1 Zoonoses

Several diseases of poultry can be transmitted to humans. Mites (primarily the Northern Fowl Mite, *Ornithonyssus sylviarum*, in Canada) and lice can live off avian hosts for some time (Kuney, 2002), and are often found on humans after handling infested chickens. However, the preferred host for these organisms is the bird, and normal human hygiene eliminates them within 1-2 days.

Several bacteria, including *Salmonella* and *Campylobacter*, are carried by poultry and cause human disease if poultry products are improperly handled or improperly cooked (Wabeck, 2002). Human disease is most commonly caused by contamination of food products, but transmission can also occur during research activities, especially those that rupture the gut.

Some viruses, such as influenza, may infect both birds and humans (and other animals). Poultry workers should receive yearly influenza vaccinations. Contingency plans should be developed to deal with potential disease outbreaks, especially if there is potential for transmission to humans.

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# 12. GLOSSARY



**Acclimation** – a persisting physiological, biochemical or morphological change within an animal as a result of a prolonged exposure to an environmental condition such as a high or low temperature; generally, the changes are reversible.

**Adaptation** – the observation that the physiology, biochemistry and morphology of any animal is usually very well matched to the environment in which it evolved; these features have been shaped by natural selection over many generations.

**Ad libitum** – free choice, usually in reference to food that is continuously available.

**Ambient temperature** – the temperature surrounding the animal: under caging conditions may refer to the temperature in the microenvironment inside the cage as opposed to temperature outside the cage in the room or enclosure.

**Analgesia** – decrease in response to noxious stimuli.

**Analgesic** – substance which reduces or ameliorates the sensation of pain.

**Anesthesia** – a state caused by an external agent, resulting in depression of the nervous system, leading to loss of sensation and motor function.

**Anxiety** – an aroused state in which there is involuntary and voluntary nervous activation.

**Aseptic** – the absence of living germs, free from septic or poisonous putrefactive products (asepsis – the condition of being aseptic).

**Attending veterinarian** – a veterinarian that provides clinical care for the animals, and may only dedicate a portion of his or her professional time to working with a specific scientific institution.

**Barrier** – in the context of animal facility design, a barrier consists of physical systems and/or performance criteria that limit the transmission of etiologic agents of disease.

**Biocontainment** – the quarantine or isolation of biohazards such as bacteria, viruses, fungi or other infectious agents that may be pathogenic to humans, animals or other forms of life.

**Biopsy** – the surgical removal of a cell or sample of tissue for diagnostic purposes.

**Biosafety** – the proper use of containment barriers (inclusion), safety equipment and procedures to ensure the safety of all personnel, other animals, the public and the environment.

**Biosecurity** – the prevention of animal infections and infestations from entering a unit from outside sources; biosecurity is achieved through the use of exclusion barriers.

**Biotechnology** – the use or development of techniques using organisms or parts of organisms to provide or improve goods or services.

**Breed** – a population of animals within a species, which differs from those in other populations within the same species in respect to definite genetically determined traits.

**Cannula** – a tube (may be plastic or glass) which is inserted into the intravascular compartment or into the body to facilitate administration or withdrawal of gases or liquids.

**Cardiac puncture** – penetration of the heart, usually for removal of a blood sample.

**Clone** – genetically identical cells derived from the same cell.

**Conditioning** – term applied to examination and preparation of animals for research.

**Distress** – a state of excessive stress in which the animal is unable to make the necessary adaptations to stressor(s).

**Dorsal recumbency** – lying down on the back.

**Ecosystem –** a complex of the plant and animal communities within an area, along with the non-living components of the environment and the interactions among these.

**Embryo –** the early or developing stage of any organism.

**Estrus –** the period when mating may occur.

**Ethics** – a system of moral principles or standards governing conduct.

**Euthanasia –** literally, a good death; rapid loss of consciousness and death, with no pain or distress accompanying the procedure.

**Exsanguination** – a procedure causing extensive loss of blood due to internal or external hemorrhage.

**Farrow** – the act of giving birth by sow (guinea pigs or swine).

**Fetus** – a fully developed embryo (ie. all germ layers fully differentiated forming) in utero.

**Food chain** – a sequence of organisms, each of which uses the next lower member of the sequence as a food source.

**Gene –** the hereditary unit that occupies a fixed chromosomal locus, which through transcription has a specific effect upon phenotype.

**Genetically-engineered animals** – animals in which there has been a deliberate modification of the genome either via a technique known as transgenesis (when individual genes from the same or a different species are inserted into another individual) or by the targeting of specific changes in individual genes or chromosomes within a single species, i.e. targeted removal of genes (knock-outs) or targeted addition of genes (knock-ins).

**Genome –** the total genetic material contained within the cell.

**Genotype** – the genetic constitution of an animal, as distinguished from its phenotype.

**Gestation –** the period between conception and birth, which includes embryonic and fetal life.

**Hematocrit –** the volume percentage of erythrocytes (red blood cells) in whole blood; also Packed Cell Volume (PCV).

**Humane** – conditions which promote physical and behavioral well-being of animals; in the case of euthanasia, humane methods are those which are painless, minimize fear and anxiety, and are reliable, reproducible, irreversible, simple, safe and rapid.

**Humidity (relative) –** the ratio of the quantity of water vapour actually present in the air to the amount of water vapour that air is capable of holding at the given temperature.

**Immobilization** – a procedure causing loss of the ability to make coordinated, purposeful movements.

**Immunocompromised** – the condition in which the immune system is not functioning normally.

**Intravenous (IV)** – delivered into a vein.

**Jurisdiction** – the physical area over which an institution has authority (i.e. the buildings and land owned by the institution).

**Litter** – a) numerous young born at one time of a single female; b) in reference to bedding may mean straw, hay or other material used for the purpose of bedding.

**Major surgery** – a surgical procedure in which there is direct visual access to a major body cavity (cranium, spinal canal, thorax, abdomen, pelvis) and/or exposure of major vascular, muscular, skeletal, neural, lymphatic or glandular structures and/or removal of, or alteration to, a functionally significant amount of tissue. There is no clear boundary between Major and Minor Surgery; thus Animal Care Committees (ACC) should use definitions of these terms only as adjuncts to the Categories of Invasiveness, and should seek additional professional judgment when the level of invasiveness and injury is unclear.

**Microenvironment** – a small, isolated habitat, usually within a cage.

**Morbidity –** visible manifestation of a diseased state.

**Mortality –** loss of life; death.

**Necropsy –** systematic dissection of an animal after death to elucidate the cause of death; same as postmortem examination. Necropsy is the preferred term for animal postmortem examinations, as opposed to autopsy for human-beings.

**Pain –** an unpleasant sensory and emotional experience associated with actual or potential damage, or described in terms of such damage (International Association for the Study of Pain®, http://www.iasp-pain.org/terms-p.html).

**Pathogen –** an organism which causes disease.

**Parturition –** the act or process of giving birth.

**Phenotype –** the outward visible expression of the hereditary constitution of an organism.

**Postmortem –** an examination of the body made after the death of the animal; a necropsy.

**Postoperative –** occurring after a surgical operation.

**Prophylaxis –** prevention of disease.

**Protocol –** a written description of a study or activity that includes details of the goals, the use of animals, the procedures that are to be followed and the personnel involved; the purpose of the protocol is to ensure the quality and integrity of the study or activity.

**Quarantine –** the segregation or isolation of animals from all others to prevent the spread of disease.

**Restraint –** holding or securing to reduce activity in order to prevent the animal from causing harm to itself or harm to the handler.

**Roughage –** food that is high in fibre and low in digestible nutrients.

**Ruminants –** polygastric animals usually having four digestive compartments.

**Sanitize –** to reduce the level of microorganisms to an acceptable health level.

**Sexual maturity –** the age at which the animal is first able to reproduce.

**Standard Operating Procedures (SOPs) –** written documents specifying procedures for routine activities that must be followed to ensure the quality and integrity of the study.

**Stereotyped behaviour –** behaviour repeated in a very constant way. The term generally is used to refer to behaviour that develops as a consequence of a problem situation such as extended social isolation, low level of environmental complexity, etc.

**Sterilization –** a) the complete destruction of microorganisms by heat, chemical compounds, mechanical or physical means; b) in animal breeding, refers to any procedure which renders the animal incapable of reproduction.

**Stock –** a collection of outbred animals being grown or maintained for breeding or for experimental use.

**Strain –** a group of animals of known ancestry maintained by a planned inbreeding mating system; generally with some distinguishing characteristics.

**Stress –** a strain upon the normal physiological or psychological processes or functions of the body, organ or tissue. Some stresses may cause pathology or diseased states, or weaken the normal body defences.

**Subcutaneous (SC) –** beneath the skin.

**Thermoregulatory –** able to regulate heat.

**Tissue culture –** the propagation of tissue removed from organisms in a laboratory environment that has strict sterility, temperature and nutrient requirements.

**Vector –** a living thing that is capable of carrying and transmitting infectious agents.

**Vermin –** any undesirable or disturbing offender such as flies, lice, fleas, cockroaches, ticks, mice, rats, weasels.

**Welfare –** a term used to describe the quality of life that an animal is experiencing.

**Well-being –** a state or condition of physical and psychological harmony between the organism and its surroundings. Good health and manifestation of normal behavioural repertoire are the most commonly used indicators of an animal's well-being.

**Withdrawal time –** the length of time between when an animal is given a drug and the prescribed time period for clearance of residues of that product.

**Workplace Hazardous Materials Information System (WHMIS) –** a federal system to provide information on hazardous materials used in the workplace; it concentrates on three key elements: labels, material safety data sheets, legislation and employee education.

**Zoonotic –** relating to the transmission of a disease from a non-human species to humans.

**Zoonosis –** a disease of animals that may under natural conditions be secondarily transmitted to humans.

# APPENDIX A
# LIST OF ORGANIZATIONS



Agriculture and Agri-Food Canada (AAFC)

Alberta Agriculture, Food and Rural Development

Alberta Farm Animal Care (AFAC)

Association Ontario Farm Animal Council (OFAC)

BC Ministry of Agriculture Food and Fisheries

Canadian Agri-Food Research Council (CARC)

Canadian Federation of Humane Societies (CFHS)

Canadian Food Inspection Agency (CFIA)

Canadian Society of Animal Science (CSAS)

Farm Animal Council of Saskatchewan (FACS)

Farm Animal Welfare Council (FAWC)

Federation of Animal Science Societies (FASS)

Fisheries and Aquaculture New Brunswick

Manitoba Farm Animal Council (MFAC)

Manitoba Food Agriculture and Rural Initiatives

Ministère de l'agriculture, des pêcheries et de l'alimentation du Québec (MAPAQ)

National Farm Animal Care Council

Nova Scotia Department of Agriculture

Ontario Ministry of Food and Rural Affairs (OMAFRA)

PEI Agriculture, Fisheries and Aquaculture

Saskatchewan Agriculture and Food

# APPENDIX B
# FIVE FREEDOMS

The UK Farm Animal Welfare Council has defined ideal states for the well-being of farm animals:

1. FREEDOM FROM HUNGER AND THIRST
    - by ready access to fresh water and a diet to maintain full health and vigour.
2. FREEDOM FROM DISCOMFORT
    - by providing an appropriate environment including shelter and a comfortable resting area.
3. FREEDOM FROM PAIN, INJURY OR DISEASE
    - by prevention or rapid diagnosis and treatment.
4. FREEDOM TO EXPRESS NORMAL BEHAVIOUR
    - by providing sufficient space, proper facilities and company of the animal's own kind.
5. FREEDOM FROM FEAR AND DISTRESS
    - by ensuring conditions and treatment which avoid mental suffering.