

National Animal Health Emergency Management System Guidelines

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Operational Guidelines

Euthanasia

The National Animal Health Emergency Management System Guidelines provide an operational framework for use in dealing with an animal health emergency in the United States.

The guidelines are produced by the
Veterinary Services Unit of the Animal and Plant Health Inspection Service,
U.S. Department of Agriculture.

These guidelines are under ongoing review. Please send questions or comments to:

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Preface

“Euthanasia,” a component of APHIS’ National Animal Health Emergency Management System (NAHEMS) Guidelines series, is designed for use in the event of a major animal health emergency such as an incursion of a foreign animal disease or a natural disaster in the United States. The NAHEMS guidelines provide information for use by any emergency animal disease eradication organization and for integration into the preparedness plans of other Federal agencies, State and local agencies, Tribal Nations, and additional groups involved in animal health emergency management activities. Topics covered in the guidelines include:

- Field investigations of animal health emergencies
- Disease control and eradication strategies and policies
- Operational procedures for disease control and eradication
- Site-specific emergency management strategies for various types of facilities
- Administrative and resource management
- Educational resources

The NAHEMS guidelines provide a foundation for coordinated national, regional, State, and local activities in an emergency situation. As such, they are meant to complement non-Federal preparedness activities. The guidelines are being reviewed and updated on an ongoing basis, and comments and suggestions are welcome.

“Euthanasia” provides guidelines for Euthanasia Unit Leaders, Euthanasia Team Managers, Euthanasia Team Members, and associated personnel responsible for euthanasia activities. The guidelines are meant for use as a practical guide rather than as a comprehensive reference resource.

The general principles provided in the guidelines are intended to serve as a basis for making sound decisions. However, deviations from the guidelines may be permissible if necessary to address a given situation effectively. In addition, information provided in various sections may need to be combined to meet the requirements of a particular situation.

Acknowledgments

“Euthanasia” reflects the efforts of a number of individuals, including an APHIS Veterinary Services (VS) Writing Group, additional APHIS staff members, and a wide range of reviewers. The reviewers include Federal and State Veterinarians, members of APHIS’ animal health emergency response teams, officials of other Federal agencies, representatives of industry, and additional experts. The contributions of each individual are appreciated.

Also acknowledged with appreciation are the efforts of USDA staff and external reviewers involved with the development of the VS animal health publications (“red books”) and similar documents that have served as information sources for the NAHEMS guidelines. The contributions of each individual are appreciated.

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Chapter 1 Introduction

Euthanasia is practiced during a major disease outbreak to help prevent or mitigate the spread of the disease through the elimination of infected or contact animals. Qualified personnel must be used to perform euthanasia procedures in the quickest, safest, and most humane way possible.

During a foreign animal disease (FAD) outbreak, euthanasia measures are implemented to prevent or mitigate pathogen spread, thus protecting the economic viability of the agricultural industry and the nation and also—if the disease is zoonotic—the health and well-being of the public. These guidelines provide Euthanasia Unit Leaders and associated personnel with guidance on choosing and implementing optimal euthanasia methods for a range of animals and situations.

Additional Resources

The guidelines are meant for use as a practical field resource rather than a comprehensive reference work. Additional information on euthanasia may be obtained from sources such as:

- 9 CFR Part 313, Humane Slaughter of Livestock, (www.access.gpo.gov)
- Professional and trade associations (e.g., see the American Veterinary Medical Association’s “2000 Report of the AVMA Panel on Euthanasia” at www.avma.org/resources/euthanasia.pdf ; and the joint National Pork Board/American Association of Swine Veterinarians publication “On Farm Euthanasia of Swine—Options for the Producer” at www.aasv.org)
- Institutions of higher education and State agricultural extension services (e.g., the University of California, Davis, at www.vetmed.ucdavis.edu; select “Continuing Education,” “Veterinary Extension,” and “Animal Welfare;” or the University of Nebraska, Lincoln, at www.unl.edu; click on “Cooperative Extension” and then on “Publications”).
- The web site of Dr. Temple Grandin at www.grandin.com
- The agricultural ministries or departments of other countries (e.g., the United Kingdom’s Department for Environment, Food and Rural Affairs (www.defra.gov.uk; select “Animal Health & Welfare” and then “Animal Welfare”) or Animal Health Australia’s “Destruction” manual (<http://www.aahc.com.au>; select “Emergency Animal Disease Preparedness,” “AUSVETPLAN Development,” and “Destruction of Animals”).

“Euthanasia” focuses on essential areas such as the responsibilities of euthanasia personnel and euthanasia considerations and methods. The document is designed for use not only in emergency situations but also in animal health emergency training programs. A brief overview of key elements of such programs is provided below.

Emergency Response Exercises

Well before an animal health emergency strikes, euthanasia personnel should use the “Euthanasia” guidelines in emergency response exercises designed to help them expand their knowledge of animal health emergency management. Such sessions will help learners identify likely emergency scenarios and develop detailed plans for responding to each scenario effectively.

The First 24 Hours—A useful assignment challenges participants to use the guidelines to create a detailed plan for the first 24 hours of an animal health emergency. Participants can use information in the guidelines to answer questions such as:

- What actions will need to be taken immediately? If these actions are not taken, what consequences are likely?
- What relationships with other key personnel, including individuals in the emergency management community, should be in place prior to the emergency?
- To what degree will euthanasia of livestock disrupt the agricultural community? How can the effects of such disruptions be minimized?
- To what degree will euthanasia of livestock disrupt the community at large? How can the effects of such disruptions be minimized?
- What key information and resources (e.g., equipment and supplies) need to be readily available, and where and how will they be obtained, stored, and accessed?
- What key information will be needed, and how will it be obtained?
- What obstacles may appear, and how will they be overcome?
- What conflicting pressures are likely, and how will they be balanced?
- If an initial plan fails, what are the elements of an effective alternative plan?

Evaluation—The evaluation phase of test exercises will provide participants with the opportunity to use the guidelines to (a) evaluate the strengths and weaknesses of their responses in the simulation exercises and (b) focus on ways to improve their response capabilities in the event of an actual animal health emergency. The exercises also will underscore the need for participants to develop and maintain strong collaborative relationships with their counterparts in the emergency management community.

Interagency Outreach

If the presence of an FAD or arthropod vector or other type of animal health emergency is identified in the United States, the appropriate local, State, and Federal Governments and their partners in the private sector (e.g., industry and academia) must respond in a coordinated, mutually supportive manner to (a) determine the nature of the outbreak, (b) initiate an appropriate response, (c) eliminate or control the disease, and (d) help facilitate recovery (e.g., resumption of trade). The NAHEMS guidelines are designed for use at any of three levels of response commensurate with the severity of the outbreak. These levels include:

- *A local/limited response.* This level of response is managed by local, State, Federal, and industry officials, with response coordination provided primarily at the State and regional levels and with national-level consultation and consequence management (e.g., trade issues).
- *A regional response.* A regional response is managed by local, State, Federal, and industry officials—in some cases, with the involvement of the appropriate State emergency management agency as specified in State animal health emergency response plans. National-level crisis management, response coordination, consultation, and consequence management are required.
- *A national response.* This level of response requires the combined efforts of local, State, industry, and Federal agricultural officials as well as nonagricultural personnel from Government (e.g., the Federal Emergency Management Agency) and the private sector in national-level crisis management, response coordination, consultation, and consequence management.

Regardless of response level, the agricultural community must be prepared to work closely with the emergency management community to deal with an animal health emergency. The State-based, nationally coordinated Animal Emergency Response Organization (AERO) model addresses this need.

The AERO model is based on the Incident Command System (ICS), an emergency response approach used widely in the emergency management community. To promote the widest possible application and implementation of guidelines content throughout the agricultural and emergency management communities, this publication refers to the titles of officials and groups in terms of the AERO/ICS model. It is hoped that this approach will help the reader understand the essential aspects of animal emergency response activities in terms of the model.

Chapter 2 Responsibilities of Euthanasia Personnel

Euthanasia personnel provide services that are essential to an effective animal health emergency response, including the need to control and eradicate an FAD. This section of the guideline discusses the responsibilities of euthanasia personnel as well as the importance of cooperation with other units, including the Animal Welfare Unit, and the topics of hazard communication, biosecurity measures, personnel orientation, and needs assessment.

The Euthanasia Unit, which is located within the AERO Operations Section, works closely with other units to ensure a smoothly functioning operation. The Euthanasia Unit:

- Provides advice and recommendations to Incident Command and the general staff in the planning of euthanasia activities.
- Notifies owners or operators of Infected or Contact Premises (potentially exposed) of euthanasia procedures that will be used and secures acceptance for these procedures.
- Coordinates euthanasia activities with the Appraisal and Compensation Unit and the Disposal Unit.
- Performs other services as appropriate.

Key Personnel

Key Euthanasia Unit personnel include:

- The Euthanasia Unit Leader, who is based at the Incident Command Center and who plans and conducts euthanasia activities in consultation with the Operation Section Chief (to whom he or she reports) and the Incident Command.
- Multiple Euthanasia Team Members, working in teams. Each Euthanasia Team is led by a Euthanasia Team Manager and works at multiple premises. Ideally, each Euthanasia Team Manager is a veterinarian, and the Euthanasia Team Members composing the teams are individuals who have training and/or experience with the species to be euthanized.

All euthanasia personnel should learn as much as possible about the procedures discussed in these guidelines and in other information sources such as those mentioned in the previous section. They also should participate in educational sessions and emergency response exercises designed to help them expand their knowledge and expertise in the area of animal health emergency management.

The Euthanasia Unit Leader

The responsibilities of the Euthanasia Unit Leader—whether at the national, regional, State, or local level—focus primarily on ensuring that safe, humane, effective euthanasia procedures are performed on animals in all premises involved in an animal health emergency.

General Responsibilities—The Euthanasia Unit Leader should be identified well before a disease outbreak or other animal health emergency occurs. This individual:

- Ensures that up-to-date contact information is maintained on personnel who are willing and qualified to serve as Euthanasia Team Managers and Euthanasia Team Members. Complete contact information for all euthanasia personnel should include names; postal, express mail, and e-mail addresses; cell, office, and home telephone numbers; and fax numbers.
- Assigns personnel to Euthanasia Teams and appoints a Euthanasia Team Manager to supervise each team.
- Instructs Euthanasia Team Managers in euthanasia protocols and procedures, humane animal handling methods, and general safety precautions. Safety precautions are coordinated with the Safety Officer.
- Assigns Euthanasia Teams to various premises, informing owners and managers of the team members' expected times of arrival and providing additional information as needed.
- Serves as a technical resource for information on current euthanasia methods and procedures and maintains files of resource materials on these topics.
- Maintains direct contact and coordinates euthanasia activities with other units as needed, particularly the Appraisal and Compensation Unit whose activities precede euthanasia activities and the Disposal Unit whose activities follow euthanasia.
- Determines the number and types of personnel, vehicles, and euthanasia-related equipment needed to conduct euthanasia operations and communicates with the Operations Section Chief to ensure that the required resources are available.
- Identifies personnel training requirements and is responsible for (a) ensuring that employees are oriented (by the Safety Officer) to on-the-job hazards and ways to avoid these hazards, (b) explaining Euthanasia Team Members' duties to them and training them in euthanasia policies and procedures, and (c) ensuring that personnel implement proper euthanasia methods in their work.
- Prepares briefings and reports for the Operations Section Chief and notifies him or her immediately of any issues or problems.

- Verifies the accuracy and completeness of all required reports and submits them promptly for entry into the APHIS Emergency Management Response System (EMRS) or a similar acceptable reporting system.
- Works closely with other units in the animal emergency response organization.
- Cooperates as appropriate with other emergency response organizations (e.g., State emergency management agencies).
- In consultation with the Animal Welfare Unit, the Liaison Officer, and Communications Unit personnel, cooperates with animal welfare groups as appropriate.

The Euthanasia Team Manager

The Euthanasia Team Manager supervises the activities of the Euthanasia Team and is responsible for its overall effectiveness. Specifically, this individual:

- Assists the Euthanasia Unit Leader by explaining Euthanasia Team Members' duties to them, providing guidance in euthanasia policies and procedures as well as instruction in safety precautions for each operation.
- Ensures the use of humane animal handling and euthanasia procedures.
- Assigns tasks to euthanasia personnel (e.g., coordination of on-site euthanasia activities) and supervises this work.
- Coordinates plans and activities with the Appraisal and Compensation Team Manager and the Disposal Team Manager prior to the commencement of euthanasia operations.
- Assists the Euthanasia Unit Leader in determining the personnel, vehicles, equipment, and supplies required to conduct euthanasia activities efficiently.
- Ensures that the Euthanasia Team has sufficient equipment and supplies to complete the euthanasia operation.
- Ensures that Euthanasia Unit personnel comply with biosecurity measures.
- Accounts for supplies and equipment used in performing euthanasia procedures and maintains proper security for them.
- Provides complete data and sound advice to the owner and appropriate officials, securing acceptance of and support for euthanasia procedures.
- Stays current on state-of-the-art information and knowledge concerning euthanasia principles and procedures.

- Prepares briefings and reports for the Euthanasia Unit Leader and notifies him or her immediately of any issues or problems.

The Euthanasia Team Member

The work of the Euthanasia Team on an infected or contact premises is essential to the containment and control of a disease outbreak. The Euthanasia Unit Leader should assign a Euthanasia Team, including a Euthanasia Team Manager, to each premises as soon as possible after it is declared an infected or contact premises.

The Euthanasia Team consists of individuals who are skilled and experienced in euthanasia procedures and who visit each premises to euthanize livestock and poultry humanely on infected and/or contact premises. Each Team Manager and Team may be responsible for a designated area or a certain number of premises.

Before the Euthanasia Team arrives on the premises, a foreign animal disease diagnostician (FADD) or other designated official will have visited the premises to observe the animals for clinical signs of disease and to take samples. Evidence of disease, which should be documented in the EMRS or other agreed-upon alternative reporting system, will indicate that the animals and other materials on the premises are at risk of transmitting the pathogen. Accordingly, the animals will need to be appraised and depopulated.

Upon arrival on the premises, the Euthanasia Team should assist the Euthanasia Team Manager with the responsibilities outlined earlier in this section.

Cooperating with the Animal Welfare Unit

The Euthanasia Unit will work especially closely with personnel from the Animal Welfare Unit on all aspects of euthanasia related to animal welfare. The Animal Welfare Unit is located in the Operations Section. Animal Welfare Unit personnel will include field Veterinary Medical Officers and Animal Care Inspectors provided by APHIS Animal Care, who serve in an advisory capacity to ensure that animals are euthanized humanely.

Each Euthanasia Team should make a special effort to:

- Coordinate with personnel from the Animal Welfare Unit for on-premises visits to help plan, implement, and observe euthanasia activities.
- Consult regularly with Animal Welfare Unit personnel on animal welfare issues, requesting their advice as needed on individual questions or issues that arise.
- Make every effort to comply with the counsel of APHIS Animal Welfare personnel when it is reasonable and practical to do so.

Hazard Communication

Before any euthanasia work is initiated, Euthanasia Team Members should be briefed fully by Orientation/Training Unit personnel (see the NAHEMS “Roles and Responsibilities” Guidelines, in progress) about the nature of the disease with which they are dealing and reminded of the hazards associated with the euthanasia methods likely to be used. The Euthanasia Team Manager, in turn, will brief the owner, the owner’s family, and premises employees on euthanasia-related hazards. Euthanasia Team members will coordinate closely with teams from other units (e.g., the Appraisal, Biosecurity, or Disposal Teams) that may visit the premises. (These units will have been briefed previously on hazards.)

Specific safety precautions or hygiene requirements should be explained before the Euthanasia Team enters the premises. This is particularly important if a zoonotic disease is involved. In addition, the team should be supplied with all necessary safety equipment. Respirators, gloves, and eye protection, for example, must be supplied if the personnel are at risk from a disease organism or chemical hazard (e.g., asphyxiant or toxic gas), if significant amounts of dust are generated, or upon individual request. (For further information on respirators, see the APHIS Respirator Program Guidelines in APHIS’ “Safety and Health Manual,” Chapter 11, Section 3.) All personal protective equipment must be used according to guidelines established by the Safety Officer. Euthanasia Team Members should wear appropriate personal protective gear to ensure personal safety and compliance with OSHA standards.

Additional biosecurity and cleaning/disinfection procedures are required to address the risks posed by serious zoonotic diseases.

Euthanasia Team Safety

In addition to the general hazards mentioned above, the safety of the Euthanasia Team may be affected by several factors, including:

- The size and body weight of the animals to be euthanized.
- The temperament of the species being euthanized. The Euthanasia Team will be able to implement euthanasia measures more safely, quickly, and humanely if they understand the animals’ temperament and are experienced in handling the species.
- The animals’ familiarity with humans. Special care and precautions must be taken if the animals are unaccustomed to being handled by humans.
- Animals generally regarded as being dangerous (e.g., bison, bulls, sows with litters, large boars, tusked boars, and all of the cervid species.)

- Methods and/or equipment available for animal restraint. The restraining methods and equipment used must be sufficient to ensure the safety of team members. In addition, the means of restraint must facilitate the euthanasia procedure and allow adequate time for its completion.

Personnel Orientation Factsheets

Certain sections of this document may be especially relevant to the responsibilities of individual euthanasia personnel. Accordingly, the Euthanasia Unit Leader may wish to distribute one- or two-page laminated factsheets on various responsibilities or tasks to these individuals. For a sample factsheet, see “Biosecurity: DOs and DON’Ts” (Appendix I).

Assessing Needs

Needs for euthanasia personnel, vehicles, and equipment will be determined at the time of the animal health emergency by the Euthanasia Unit Leader in consultation with Euthanasia Team Managers. The Euthanasia Unit Leader will work with State emergency management agencies to identify euthanasia personnel with the required expertise from multiple Government and private sources.

The Euthanasia Unit Leader should advise the Operations Section Chief of any personnel requirements that cannot be satisfied locally so that arrangements for additional personnel can be made. The Euthanasia Unit Leader also will work with appropriate officials to issue contracts and leases regarding any equipment, supplies, or personnel for euthanasia operations.

Chapter 3 Euthanasia: General Considerations

In a major outbreak of highly contagious disease, large numbers of animals will be producing and transmitting pathogens to other animals. Thus, the more quickly large-scale euthanasia activities can be completed, the more quickly pathogen transmission can be brought under control.

Because timely initiation of euthanasia is so important, euthanasia personnel must be familiar with general considerations that are essential to planning an effective euthanasia program. A thorough understanding of primary aspects of euthanasia can help euthanasia personnel act quickly and decisively in a crisis situation.

Central to a successful euthanasia are factors such as using humane euthanasia methods, gaining public support for euthanasia activities, documenting the use of controlled substances, and minimizing personnel and owner stress. These factors are discussed below.

Humane Considerations

In general, euthanasia should take place in such a way as to minimize an animal's pain and stress. To meet this requirement, the animal should be rendered unconscious as quickly as possible. Essential to the fulfillment of this objective are the careful selection of the quickest, most humane euthanasia methods and skillful use of these methods on the part of the Euthanasia Team, as outlined in these guidelines. Public perceptions of the humaneness of the procedures used also are important, as discussed below. Euthanasia should be performed or closely supervised by a veterinarian, and each animal should be checked at the conclusion of the procedure to ensure that the procedure was successful.

Gaining Public Support

A major disease outbreak and response in this country can be expected to attract considerable media attention and interest, especially in the early stages of the incident. It is important that animal emergency response personnel work public to gain the support of the public.

The media may be helpful in raising public awareness of the necessity of the euthanasia activities for disease eradication and the humaneness of the procedures being used. The media also may document the presence of Animal care experts and representatives of animal welfare organizations invited to observe the euthanasia activities, thus providing the public with a source of reassurance that the most humane euthanasia methods are being used.

Inviting Animal Care Experts—as mentioned in a previous section, The Euthanasia Unit will coordinate with personnel from the Animal Welfare Unit for on-premises visits to help plan, implement and observe euthanasia activities and will make every effort to comply with their recommendations when it is reasonable and practical to do so.

Representatives of Animal Welfare Organizations—Information should be provided to animal welfare organizations, on a proactive basis, to educate them on the issues pertaining to disease eradication—including euthanasia—and to assure them of the humaneness of the euthanasia procedures used.

Representatives of the Communications Media—The Information Officer will regularly update representatives of the media, including updates on euthanasia activities.

If the decision is made to allow on-site visits to mass euthanasia sites, all visits should be coordinated by the AERO Information Officer in close consultation with the Incident Commander, the Operations Section Chief, the Euthanasia Unit Leader, and other key personnel. Everyone involved must understand that the Euthanasia personnel are in charge of on-site activities and that they require full cooperation for the sake of visitors' personal safety as well as the efficiency with which the euthanasia activities are completed.

AERO Information Officers should accompany visitors at all times—not only to explain procedures and answer questions but also to ensure the visitors' safety. (For additional information, see the NAHEMS "Communications" guidelines, in progress.)

Documenting Use of Controlled Substances

The use of euthanasia solutions by Federal employees must conform to VS Memorandum 583.1, "Drug Enforcement Administration (DEA) Numbers and the Use of Controlled Substances (Euthanasia Solutions)," dated September 27, 1994. VS Memorandum 583.1 appears at: http://inside.aphis.usda.gov/guidance/memoranda/vs/583_1.html.

Key components of the memorandum follow:

- Authorization for the use of euthanasia solutions will be given only to Area Veterinarians in Charge (AVICs).
- Euthanasia solutions will only be used by Federal Veterinary Medical Officers (VMOs) in their official capacity and for official purposes only.
- AVICs are responsible for the ordering and dispensing of all euthanasia solutions. This responsibility cannot be delegated to any other individual.
- Only a minimum quantity of euthanasia solution will be maintained on hand by the AVIC. This is the amount estimated to be used in one month by the Federal VMOs under the charge of the AVIC.
- Only those Federal VMOs who have an actual need for euthanasia solution will be allowed possession of euthanasia solution—in an amount not to exceed the estimated volume that would be used in a two-week period.

Minimizing Personnel Stress

Although animal euthanasia is commonly a necessary step in disease eradication, extinguishing animal life is a difficult and often stressful process. The Euthanasia Unit Leader and Team Managers should assess the experience and skills of euthanasia personnel and ensure that each individual has the information and skills he or she needs to implement euthanasia activities quickly, humanely, and effectively.

Ideally, only experienced personnel will be involved with euthanasia activities. However, even experienced personnel can experience stress. Each Euthanasia Team Manager should observe personnel for signs of undue stress and be prepared to suggest a break, a shift of duties, and a talk with a counselor, or other appropriate action. At the very least, team members should be encouraged to take frequent breaks, have regular meals, and get adequate sleep. Promoting these stress-relieving activities also helps prevent fatigue- and stress-related accidents.

Predictably, some individuals will have continued difficulty with the stress of working in a euthanasia program. If evidence of stress is observed, shift these individuals to less stressful roles in the disease eradication effort. Critical incident stress debriefing should be offered (if not mandated) for all personnel involved with mass euthanasia activities.

Minimizing Owner Stress

It is recommended that the owner and the owner's family not be present on the premises while euthanasia activities are taking place, especially if the family includes young children and/or if family members have emotional bonds with the animals concerned. As a matter of human compassion and consideration, the owner and their families should be given a complete explanation of what to expect. If the owner and the owner's family choose to stay on the premises while euthanasia activities are implemented, they may experience considerable stress. Any individuals who must deal with severe or prolonged stress reactions may wish to seek professional assistance. Community mental health facilities and religious institutions may be helpful in providing educational, counseling, and referral services for such individuals. The Euthanasia Team Manager should have information regarding such facilities on hand to provide to the owner and his or her family.

As mentioned above, the Euthanasia Team Manager should meet with the owner prior to the initiation of euthanasia activities to:

- Identify safety considerations concerning the proposed euthanasia site, including the need to confine domestic pets and uninfected animals away from the site.
- Explain the euthanasia method chosen and why it was selected.
- Suggest that the owner and the owner's family consider leaving the premises while euthanasia activities are proceeding.

Careful advance discussion of the euthanasia activities with the owner, the owner's family, and premises personnel will help build trust in the Euthanasia Team's ability to handle the animals humanely and quickly. Full advance discussion also will increase the likelihood that once euthanasia activities have begun, the team will be allowed to proceed with its work without interruption.

Chapter 4 Selecting a Method of Euthanasia

The selection of an appropriate euthanasia method for a given situation involves consideration of a number of criteria. In general, the method selected must be appropriate to the species involved and implemented according to current professional standards. The method chosen is not limited to those specified in Title 9 CFR Part 313; *Humane Slaughter of Livestock* because the four methods of humane slaughter listed there are specifically for animals which are being slaughtered for human consumption.

To ensure selection of the optimal and most humane euthanasia method for a given species, veterinarians with species-specific expertise and experience should be consulted during the planning process.

AVMA Guidelines

The AVMA provides the following guidance relative to mass euthanasia: “Under unusual conditions, such as disease eradication and natural disasters, euthanasia options may be limited. In those situations, the most appropriate technique that minimizes human and animal health concerns must be used. The options include, but are not limited to, CO₂ and physical methods such as gunshot, penetrating captive bolt, and cervical dislocation.” (p. 688)

When possible, the method chosen should be one on the acceptable list—or at least designated as “conditionally acceptable”—by the American Veterinary Medical Association (AVMA). The AVMA defines “conditionally acceptable” methods as “those techniques that by the nature of the technique or because of greater potential for operator error or safety hazards might not consistently produce humane death or are methods not well documented in the scientific literature....” (p. 673). For further discussion, see the “2000 Report of the AVMA Panel on Euthanasia” on the Association’s home page at www.avma.org (select “2000 Euthanasia Report” under “Features”).

Reference materials and training

Those personnel responsible for directing euthanasia operations should have a working knowledge of the resources listed in Section 1 of these guidelines and the information available from Dr. Temple Grandin on her web site at www.grandin.com

Another important element of humaneness concerns the expertise of the individuals performing the euthanasia. *The role of proper personnel training in minimizing animal pain and stress during euthanasia cannot be overemphasized.* Personnel who are assigned euthanasia responsibilities must have appropriate training and experience with the animal species to be euthanized and the euthanasia method to be used.

General Considerations

A number of issues must be considered when selecting the method of euthanasia. A partial list of the issues would include:

- Species and size of the animals
- Environment where animal is maintained (e.g., pasture, feedlot, dairy barn, swamp)
- Need for specialized equipment (e.g., firearm, gas chamber, chemicals)
- Public acceptance of euthanasia method
- Risk of spreading the disease agent
- Hazard to the environment
- Degree of animal restraint required
- Sample contamination as a result of the euthanasia method
- Possible use of the animal carcass (e.g., if the carcass were to be used for food the animal must be euthanized in accordance with the Humane Slaughter of Livestock requirements of 9 CFR Part 313.)

Each of these items should be listed and a suitable remark drafted to provide “talking points” in case the method of euthanasia selected is questioned at some future time. Other issues which are unique to the time, place, or situation should be added to the list to make as complete a document as possible.

Personnel Considerations

Personnel-related criteria to consider in the selection of a euthanasia method include:

- The availability of sufficient personnel to implement a given method (e.g., a number of personnel may be needed to help with animal gathering and restraint during euthanasia activities).
- The training, experience, and skill of available personnel.
- Attitude of personnel – each individual must make it a personal responsibility to assure that every animal handled and killed is treated in the most humane manner possible.
- Personnel safety during the implementation of the method.

These factors are discussed in greater detail elsewhere in these guidelines.

Protection of the Public

Euthanasia should be performed in such a way and in such a location as to ensure public safety and to protect the public from having to view euthanasia activities. As mentioned earlier, the communications media can play a significant role in educating the public about disease eradication and in building public support for a disease eradication program, including euthanasia activities.

Site Selection

The selection of a euthanasia site will depend on a number of factors. In general, the following criteria should be considered:

- *Protection of bystanders and uninfected animals.* If feasible, animals to be euthanized should be moved away from bystanders and neighbors, from the view of the public, and from uninfected animals, including wildlife. Pet animals and other animals not designated for euthanasia should be confined well away from the euthanasia site. Live animals infected with a highly contagious disease should not be transported past premises with susceptible species.
- *Avoidance of the risk of harm to property from the euthanasia method.* If gunshot is used, for example, the euthanasia site should be located in such a way as to protect premises buildings and other livestock from stray or ricocheting bullets.
- *Availability of facilities and equipment, including methods of animal restraint.* Factors in regard to the amount of control and the kind of restraint required include the animal's species, breed, degree of domestication, temperament, behavioral characteristics, size, weight and degree of excitement as well as the presence of pain or disease.

Sequence of Euthanasia Activities

Euthanasia personnel should plan to euthanize the designated animals on premises in a sequence that takes into account the risk the animals pose for the spread of the disease agent. In general, animals should be euthanized in descending order of priority, as follows:

- Animals with the greatest propensity to shed disease agent (e.g., infected swine are reported to produce 100 to 1000 times greater concentration of FMD virus in aerosols than do cattle.)
- Animals showing clinical signs of the disease of concern.
- Animals that have had contact with the diseased animals.
- Animals susceptible to the disease of concern.

Professional judgment should be exercised in determining exactly which animals are euthanized first. Consider humane issues, level of agitation of individual animals, and difficulty of handling individual animals.

Method Selection

For each euthanasia situation, criteria for selecting the optimal method of euthanasia should include:

- The extent to which the method induces loss of consciousness and death in the animal quickly and with minimal pain, distress, anxiety, or apprehension.
- The method's availability, reliability, and irreversibility.
- The training, experience, and skill of available personnel.
- Personnel safety in implementing the method.
- The method's compatibility with the situation's requirements and purpose. (e.g., use of captive bolt when animals can be adequately restrained and gunshot when they can not be restrained.)
- The number of animals to be euthanized. (e.g., controlled substances may be feasible for euthanizing a small number of animals but not reasonable or practical for large numbers.)
- The emotional effect of the method on personnel, owners, and observers.
- The location, size, weight and species of the animals to be euthanized.
- Availability of facilities including adequate means of animal restraint. See next section.
- The compatibility of the method with subsequent plans for evaluation, examination, or use of animal tissue (e.g., the need to leave a cow's brain intact if it is to be analyzed for the presence of bovine spongiform encephalopathy).

Animal Handling and Restraint

Before euthanasia activities are initiated, animals designated for euthanasia must be appraised by personnel from the Appraisal Unit. (For further information, see the NAHEMS "Appraisal and Compensation" guidelines, in progress.)

Proper animal handling and restraint will make or break the euthanasia operation. In all cases, the animals should be handled as calmly, quietly and gently as possible.

- Proper handling is important in minimizing animal pain and distress, ensuring the safety of the personnel performing the euthanasia procedure, and protecting other people and animals in the area.
- Some methods of euthanasia require that animals be restrained physically by euthanasia team members. If individual animal restraint is necessary, ensure that an adequate number of personnel are available before moving the animal from its housing.
- Animals which can not be handled safely should be euthanized in their customary housing, when possible, to eliminate the agitation of moving. When this is done, the carcass should be removed immediately so that rigor mortis does not impede handling.
- Personnel involved in the planning of animal handling and restraint should be familiar with the work of Dr. Temple Grandin (See Reference Materials and Training), who has worked extensively with the slaughter industry in refining animal handling facilities.

Chapter 5 Practical Methods of Mass Euthanasia

The euthanasia methods used by AERO personnel must be humane, safe, appropriate to the species involved, legal for use in the jurisdiction, and implemented according to current professional standards. Individuals making decisions regarding the method of euthanasia should be thoroughly familiar with the reference material mentioned in Chapters 1 and Chapter 4.

While the use of euthanasia methods or agents listed by AVMA as being “acceptable” or “conditionally acceptable” are desirable with regard to public perception, there are new methods being developed which have not had AVMA Panel review. Guidance for mass euthanasia was quoted in Section 4 under AVMA Guidelines but bears repeating here: “Under unusual conditions, such as disease eradication and natural disasters, euthanasia options may be limited. In those situations, the most appropriate technique that minimizes human and animal health concerns must be used. The options include, but are not limited to, CO₂ and physical methods such as gunshot, penetrating captive bolt, and cervical dislocation.” (p. 688)

The “2000 Report of the AVMA Panel on Euthanasia” lists a great many methods of euthanasia. Euthanasia personnel should read that document. Only those methods of euthanasia which are practical for mass euthanasia during disease outbreaks will be further considered in this document. Likewise, only species which might figure in an agricultural disease emergency will be treated further in this document.

Physical Methods

Physical methods are an appropriate—and often a preferred—method of mass euthanasia. Personnel using such methods should be skilled in the physical technique or experienced in the use of the equipment. Extreme care should be exercised in performing procedures to prevent harm to the operator or others in the immediate area. Adequate training for inexperienced personnel and a clear demonstration of proficiency should be required before they are permitted to use an unfamiliar euthanasia method. To practice various forms of euthanasia, personnel should use anesthetized or dead animals, and supervisors should ensure that all personnel are proficient.

Penetrating Captive Bolt and Gunshot—for purposes of euthanasia, these two techniques are treated together because the penetrating captive bolt is, in fact, a special type of firearm that is placed in contact with the skull. In a mass euthanasia situation, the penetrating captive bolt or gunshot would be the most practical method to use to euthanize numerous animals. These methods are especially useful when the animals weigh more than 200 pounds.

While penetrating captive bolt and gunshot, when properly applied, are usually fatal, it is strongly recommended that an adjunct measure (e.g., exsanguination via carotid or brachial arteries or thoracotomy) be used to ensure rapid death and prevent the possibility of an animal that may be only stunned regaining consciousness. If an adjunct measure is not to be routinely used, then a veterinarian or an individual specifically trained should inspect each animal to ensure clinical death.

A safety supervisor—a qualified individual *other than* the handler of the firearm—should be on site during all firearm related euthanasia activities. As a safety measure, all nonessential personnel should be excluded from the site before firearm related euthanasia activity is begun.

Close coordination with the law enforcement agencies within the jurisdiction where mass euthanasia is taking place with firearms is clearly needed so that all concerned can be aware of what is taking place. The Chief of Police and Sheriff should be invited to planning sessions once the decision to use firearms has been made. The presence of a uniformed law enforcement person at a location where firearms are being used, if only at the premises entrance, is a positive image which can help allay public concern.

Euthanasia by penetrating captive bolt or gunshot is dangerous and should be performed only by a limited number of highly skilled personnel using firearms appropriate to the situation. Firearm handlers should demonstrate a thorough understanding of the firearm to be used and should receive periodic training from an approved source in safe firearm use and handling. The Incident Commander must, in writing, approve all personnel who use firearms. If possible, hire the persons who handle the captive bolt weapons at local slaughter houses to perform euthanasia activities since they are experienced with those weapons. Proper cleaning and maintenance is crucial.

The amount of energy necessary to adequately stun (not kill) an animal with a penetrating captive bolt weapon is indicated in the guidance notes on Captive-bolt Stunning of Livestock published by the Humane Slaughter Association which is "...a registered charity committed to the welfare of animals in markets, during transport and to the point of slaughter." In the discussion of percussive stunning, the statement is made that "...the amount of energy required for an effective stun is 130 Joules." This is approximately equal to 95 ft lbs of energy. This value will provide a starting point for further discussion about the muzzle energy requirements for stunning and killing of livestock.

Two examples of captive bolt firearms are the Magnum 25™ Captive Bolt Stunner, (\$658*) and the Cash Special Captive Bolt Stunner (\$850*) sold by Koch Supplies (www.kochsupplies.com). The .25 caliber cartridges for these two stunners are \$100.50/1000* and \$89.50/1000* respectively. (*late 2003 prices from the manufacturer) The cost to euthanize one animal counting maintenance and wear and tear on the weapon would be about \$.50.

When gunshot is the method of choice, it is important that firearm handlers use a caliber of firearm, projectile and propellant load that are appropriate for the species being euthanized, the location of the procedure, and the overall situation. Section 313 of 9 CFR provides that projectiles shall be, "hollow pointed bullets; frangible iron plastic composition bullets; or powdered iron missiles." Hollow pointed bullets or other controlled expansion ammunition are desirable in two ways: first, to maximize tissue damage so there is little chance of an animal regaining consciousness, and second, to prevent the round from exiting the carcass and causing unintended damage. The negative side of using a controlled expansion projectile is that, in case of collateral damage to a human, the wound will be much worse than that produced by full metal jacket ammunition.

Full metal jacket (FMJ) rounds should NOT be used in a mass euthanasia situation. The FMJ round was mandated by the Geneva Convention of 1922. The purpose of enclosing bullets with full metal jackets was to reduce combat fatalities. If no major organs or bones were struck the bullets passed completely through the body without expending all their available energy and only wounded the victim. FMJ rounds also present a significant risk from ricochet although no projectiles other than the fragile iron plastic composition and the powdered iron projectiles are completely free of that risk.

For reference purposes in choosing a suitable handgun for euthanasia of livestock, the following chart gives the weight of the projectile, muzzle velocity, and muzzle energy available with various handgun cartridges that are in common use. The weights of the various projectiles were deliberately kept as accurate as possible, except when the selection of possibilities was limited.

Handgun Cartridge	Weight	Muzzle Velocity	Muzzle Energy
.380 Automatic	95gr	955fps	192 ft lbs
.38 Special +P	125gr	945fps	248 ft lbs
.40 S&W	180gr	1010fps	408 ft lbs
.45 Automatic	185gr	1000fps	411 ft lbs
.357 Magnum	180gr	1180fps	557 ft lbs
.41 Remington Magnum	175gr	1250fps	607 ft lbs
10mm Automatic	175gr	1290fps	649 ft lbs
.44 Remington Magnum	210gr	1250fps	729 ft lbs

A firearm used for euthanasia of livestock does not have the inertial limitation of a captive bolt weapon. In the firearm, a powder charge pushes the projectile out of the weapon. Once the projectile exits the barrel it has no more effect on the weapon. In the captive bolt weapon, a powder charge propels the bolt (projectile) for only a short distance. The captive bolt weapon must then absorb all of the remaining energy that has not been expended penetrating the skull of the animal. The figure provided earlier (95 ft lbs) for a captive bolt weapon is, necessarily, a compromise between having enough energy to reliably stun the animal and limiting the energy so that the weapon and operator do not take unnecessary wear and tear. Even with this compromise, the seals and stop washers in the captive bolt weapon must be replaced reasonably often in the course of normal maintenance.

Providing the energy to reliably stun an animal is all that can be realistically asked of a captive bolt weapon. Inertial limitations do not apply to a firearm with a free projectile. The captive bolt weapon has a hard steel rod which will reliably penetrate the skull. A weapon utilizing controlled expansion projectiles or other “soft” projectiles needs several times the muzzle energy to ensure penetration of the skull. For this reason it is suggested that a minimum of 300 ft lbs of muzzle energy be available for firearms used in mass euthanasia for animals up to 400 pounds body weight. For animals that are greater than 400 pounds body weight, at least 1000 ft lbs of muzzle energy should be available to ensure reliable skull penetration. In a mass euthanasia situation it is not desirable to stun the animal and have to apply an adjunct measure. The high muzzle energies suggested here are to ensure skull penetration and lethal effect such that adjunct measures will not be required.

With mature animals (e.g., bulls, swine, rams or bison), if skull penetration problems become evident even with the recommended 1000 ft lbs of muzzle energy, it may be necessary to switch from simple hollow point or controlled expansion projectiles to a projectile like that in the Winchester Supreme® Failsafe® which has a solid copper alloy nose with a notched hollow point cavity and a lead core protected by a steel insert. It is engineered for deep penetration through thick, tough skin, heavy muscle tissue and bone. A round of this extreme penetrating ability should NOT be used for the average animal because ideally the spent projectile will never exit the animal but will expend all of its energy internally.

Comparing the recommended muzzle energies to those of the .380 Automatic or the .38 Special, it can be seen that these cartridges should not be considered for mass euthanasia because they do not meet the minimum muzzle energy requirement. On the other hand, excessively powerful handgun cartridges do not provide a significant enough advantage to justify the wear and tear on the operator. If higher muzzle energies are needed, a rifle is the logical answer.

The following chart provides comparison information for some rifle cartridges in common use. The weight of the projectile was deliberately kept as close as possible in weight except when the selection was limited. There are many other big game hunting rifles which are not included in this chart because they represent a technology which is far beyond that needed in the mass euthanasia situation unless the animals can not be handled and instead must be hunted. If animals can not be handled and are to be hunted, then the hunter should have input into the choice of weapon. A cartridge should be chosen that will put at least 1000 ft lbs of energy on target which presumably will not be beyond 300 yards. Two examples of suitable cartridges are provided in the chart. All of the examples compared here are available with “hollow-point” or “controlled expansion” projectiles.

Rifle Cartridge	Weight	Muzzle Velocity	Muzzle Energy	Energy at 300 yards	
.22 long rifle rim fire	40gr	1150fps	117 ft lbs	-	Do Not Use
.22 Winchester Mag	34gr	2120fps	338 ft lbs	-	Do Not Use
.30 Carbine	110gr	1990fps	967 ft lbs	262 ft lbs	Do Not Use
.357 Magnum (rifle)	158gr	1830fps	1175 ft lbs	337 ft lbs	
.223 Remington*	64gr	3020fps	1296 ft lbs	574 ft lbs	*5.56mm NATO
30-30 Winchester	150gr	2390fps	1902 ft lbs	651 ft lbs	
.308	150gr	2820fps	2648 ft lbs	1193 ft lbs	
30-06 Springfield	150gr	2920fps	2841 ft lbs	1455 ft lbs	

Aiming the projectile—a working knowledge of the anatomy of various species is required to ensure that a properly aimed projectile enters the animal’s brain and causes instant unconsciousness. All personnel and observers should be reminded that motor activity may continue for a time despite instant unconsciousness, especially in swine. The “target point” for most animals can be located by drawing imaginary lines from each ear to the opposite eye. Where the lines intersect in the middle of the forehead is the proper entrance point. In the case of firearms, the angle of fire should cause the bullet to exit through the foramen magnum. Persons who have not studied anatomy of the animal species should have careful instruction to help them

visualize the location of the foramen magnum since the path of the projectile is critical to successful euthanasia. In the case of a captive bolt weapon, it should be aimed as though the bolt is a free projectile as instructed above.

Blow to the head

While countless millions of animals have been stunned by a blow to the head with a hammer back in the days of the “knocking box” in slaughter houses, technology has moved on in the form of the penetrating and non-penetrating captive bolt weapons. Indeed, the non-penetrating captive bolt weapon was developed to make the stunning of adult animals less physically demanding for the “knocker” and more controlled in its application. The stunning of animals by a blow to the head is used primarily to euthanize small laboratory animals and neonates with thin craniums. A single sharp blow must be delivered to the central skull bones with sufficient force to produce immediate depression of the central nervous system. If the blow is properly delivered, unconsciousness results rapidly.

In a young animal, (<100 pounds) with proper restraint, a blow to the head might well produce death. However, in an adult animal, even a properly applied blow to the head would at best stun the animal so that an adjunct measure would have to be immediately applied to ensure a humane death. The problems of restraint are too great, and the chances of an animal moving to deflect the blow too likely, to use a manual blow to the head in any mass euthanasia situation.

Electrocution

Electrocution is the causing of death by the passage of electrical current through the body. While an alternating electrical current can both stun and kill, an electrical current passed through the body from one random point to another may or may not cause unconsciousness depending on whether it passes through the brain. An animal must always be stunned before alternating current is passed through the body to produce ventricular fibrillation and death. An animal electrocuted without stunning will remain conscious for a number of seconds following the onset of ventricular fibrillation. Passing electrical current through the body without prior stunning is not humane.

Electrocution can be done in a one-step or a two-step operation. In the two-step operation, electric current is first applied to the head and passes through the brain producing immediate unconsciousness. This step will only stun the animal without killing it. Even if the current is large enough to cause physical damage to the tissues it passes through, the animal will in all likelihood recover from being stunned. Whatever adjunct measure is to be applied to ensure death must follow stunning immediately. As a second step, a sufficiently large alternating current is applied to the body so that it passes through the heart, causing ventricular fibrillation with resultant cardiac arrest and respiratory collapse. In the one-step operation, the electric current is applied to the head and feet of the animal so that current passes through the brain and heart at the same time producing unconsciousness and fibrillation of the heart.

Although electrocution under controlled conditions is an acceptable method of euthanasia, its disadvantages far outweigh its advantages in most applications. The method is hazardous to

personnel unless applied with equipment which is specifically designed for the technique. It is impractical for mass euthanasia unless the equipment for electrocution and animal handling (e.g., conveyor restrainer) can be installed in a central location where large numbers of animals can be euthanized on an assembly line basis. The use of centrally located equipment of the same design used in slaughter facilities has been very successfully used in euthanizing large numbers of swine in the Accelerated Pseudorabies Eradication Program. It is possible that such equipment may be found in local slaughter houses which could be leased for the duration of an emergency.

If electrocution is to be used in mass euthanasia situations the equipment should be obtained from the same manufacturers that supply the slaughter industry. These suppliers have the experience to produce equipment which operates reliably, efficiently, and meets all OSHA requirements for operator safety. Under no circumstances should makeshift equipment with minimal safeguards for the operators be utilized in the field.

Mobile equipment for euthanasia of poultry has been developed by at least two different groups and should be seriously considered for large scale field testing during the next outbreak of poultry disease. The equipment that has been developed is readily transportable and can be set up on the farm so transport of live diseased poultry off of the farm would not be necessary.

Equipment for mass euthanasia of large animals should be constant current devices capable of supplying 250v– 450v at 3 to 5 amperes and should operate at 60 Hz, which is normal power line frequency in the United States. When applied to the heart, only 80ma to 100ma of current is required to produce ventricular fibrillation, however, all of the current does not flow through the heart when electrodes are applied to the exterior skin of an animal. Voltages as low as 40V dc or 32V ac rms are potentially dangerous. The higher values mentioned above are necessary to assure adequate current flow through the heart, allowing for the high resistances of skin and hair and the shunting of current through musculature and other organs.

A recommended short article with specific information relative to various species is “Euthanasia and slaughter of livestock” by Temple Grandin, PhD, JAVMA, Vol 204, No. 9, May 1, 1994. A much more comprehensive article with an extensive bibliography is “Cardiac Arrest Stunning of Livestock and poultry With 1997 Updates,” by Temple Grandin which is available on her web site.

Chemical Methods

The injectable euthanasia agents should always be considered when the animals to be killed are ones that caretakers are closely associated with or which are pets, such as horses. The syringe and needle are somehow perceived as being more refined and humane than the physical techniques discussed above.

Any product to be used for lethal injection must be recognized as an effective and humane killer. The barbiturate anesthetic agents meet these criteria and are the principle drug used in several of the injectable euthanasia agents that are on the market. Two examples of injectable euthanasia agents which are commercially available include Fatal-Plus® by Vortech Pharmaceuticals and Somlethol distributed by J.A. Webster, Inc. These products are dosed at 1ml per 10 lbs of body

weight. Fatal-Plus® has 392mg/ml pentobarbital sodium and costs \$53.10*. The cost of euthanizing an 1100 lb cow with this product would be \$23.36. The Somlethol has 389mg/ml pentobarbital sodium and costs \$39.92*. The Cost of euthanizing an 1100 lb cow with this product would be \$17.57. Other commercially produced injectable anesthetic agents can be used for euthanasia if they reliably cause death when overdosed. (* late 2001 prices from a distributor)

Intravenous injection requires proper animal restraint. The restraint applied should never cause excessive fear or stress. When the animals are not amenable to physical restraint the use of chemical restraint or another method of euthanasia should be seriously considered. Under some circumstances, restraining a dangerous large animal for intravenous injection may prove difficult, and the animal may cause injury to itself or injury to personnel before a sedative can take effect. In such cases, the animal can be given an immobilizing agent such as succinylcholine for restraint purposes only. An anesthetic must be administered as soon as the animal can be controlled. Succinylcholine must never be used for euthanasia—either alone or administered concurrently with anesthetic. The use of paralytic agents alone is not humane. Paralytic agents could be used as a lethal adjunct measure after the animal has reached a plane of deep anesthesia.

A number of products such as xylazine (analgesic, sedative), ketamine, and phencyclidine (dissociative anesthetics) are not suitable for euthanasia but are excellent for chemical restraint or when dosed heavily in preparation for a lethal adjunct measure.

Since deep anesthesia can mimic death so effectively, one problem with the injectable anesthetics is the need to absolutely determine that death has taken place. This can be done by way of close clinical examination or by the routine application of a lethal adjunct measure. Physical adjunct measures were mentioned above. Chemical adjunct measures include injection of lethal amounts of products such as chloral hydrate, chloral hydrate and magnesium sulfate, neuromuscular blocking agents or various alkaloid poisons. Potassium Chloride (KCl) which is not controlled and is readily available will produce cardiac arrest when bolused by the intravenous or intracardiac route. The dose of KCl required is 7.2gm/100Kg of body weight. Any product to be used as a lethal adjunct measure should be one with specific published clinical properties. A mass euthanasia situation is no place for the use of any of the various strange chemical combinations and household products which have been reportedly used for euthanasia in the past.

Carcasses which have been contaminated with injected euthanasia agents should not be left where scavengers have the opportunity to eat them and become secondary victims of the chemicals used. Barbiturates have been particularly problematic in this regard when dosed at levels producing euthanasia. Many rendering companies will no longer accept animal carcasses with barbiturate residues because their products are incorporated into pet food. The potassium chloride mentioned above could be expected to be harmless to scavengers or pets. There should still be reasonable concern if chemicals have been used for restraint. If scavenging of carcasses by wildlife is likely or if rendering is the method of disposal, the use of physical methods of euthanasia rather than chemical methods are clearly indicated.

While not likely in most countries, if the situation should ever arise that animals being killed in the course of disease control were going to be salvaged for human consumption, use only those euthanasia methods which are specifically mentioned in 9CFR313, “Humane Slaughter of Livestock.”

Gas euthanasia

Gas has been used in the mass euthanasia of poultry far more often than it has with mammals. Carbon dioxide has been used commercially in slaughter houses to stun swine which were then exsanguinated. Carbon monoxide has been used in animal shelters with somewhat mixed success due in all probability to variations in how the gas was generated.

In cases where simple asphyxiants (e.g., carbon dioxide, nitrogen) or chemical asphyxiants (e.g., carbon monoxide) are used, personnel must be provided with appropriate training. Suitable safety equipment (e.g., a self-contained breathing apparatus and oxygen equipment) should be available on site. All equipment must be utilized according to guidelines reviewed or established by the AERO Safety Officer.

Oxygen excluding—any simple asphyxiant which will exclude oxygen and which is not noxious or irritating could, in theory, be suitable to euthanize animals. An animal exposed to an atmosphere which is completely devoid of oxygen will lose consciousness very rapidly. Nitrogen and argon have been specifically investigated in this regard and found to be effective although the AVMA guidelines note that, “...other methods of euthanasia are preferable.”

Apparently the loss of consciousness is not preceded by adequate physiologic change to serve as a warning because two human fatalities occurred when the individuals were transferring semen straws from one liquid nitrogen storage container to another inside a van. The van was completely closed due to the winter weather and apparently the agitation of handling caused the release of enough nitrogen gas to lower the oxygen content sufficiently to kill the occupants with no sign of struggle. The number of reports of normal, healthy individuals being killed by suffocation in manure pits, silos, wells, and other confined spaces underlines the effectiveness of low oxygen levels in producing rapid unconsciousness without warnings that could be stressful to an animal.

In a well ventilated room, with adequate oxygen levels, there would be no health hazard to the operator of equipment using nitrogen or argon since these two gases are nontoxic at normal atmospheric pressure.

Carbon dioxide—this normal metabolic product is an anesthetic when used at a high enough concentration (25% and above). The speed of induction is directly related to the concentration of carbon dioxide. It is heavier than air which makes it convenient to use in open top containers providing there is protection from moving air which would tend to remove carbon dioxide and stir oxygen into the container. When used outside in roll-off dumpsters, the top must be covered with a tarp to prevent wind from stirring the gas.

Carbon dioxide has been used to euthanize a wide variety of animal species. The only real limitation to its use is in having chambers or troughs which are large enough to totally submerge the animal. When carbon dioxide is used, the animal must either be left in the gas long enough to ensure that it is dead or a lethal adjunct method must be immediately applied. Animals which are removed from carbon dioxide before clinical death are likely to spontaneously recover.

Carbon dioxide is readily available in several sizes of tanks from those that can be hand carried up to those that are permanently trailer truck mounted. There is no system for local generation of carbon dioxide that can match the convenience and controllability of that available in tanks of compressed gas. Under no circumstances should animals be exposed to the solid form, "dry ice," because of the extremely cold temperatures (-109.3°F or -78.5°C). Generation of carbon dioxide from chemicals or obtaining it from a fire extinguisher is impractical in mass euthanasia situations and should not be considered.

Carbon monoxide—Carbon monoxide is a chemical asphyxiant which combines with heme, the iron molecule in hemoglobin that normally carries oxygen, and impedes the normal transport of oxygen. The dangers to the operator of equipment using carbon monoxide are so profound that the physiologic and safety aspects of using this gas will be discussed first, followed by discussion of its use in mass euthanasia.

Exposure to very low levels of carbon monoxide for long periods of time is dangerous due to the fact that carbon monoxide has more than 200 times the affinity for hemoglobin than oxygen has. Since air is about 21% oxygen, it would require only 0.1% carbon monoxide in the atmosphere to produce a level of 50% carboxyhemoglobin in the blood. Unconsciousness and death become probable when the carboxyhemoglobin level exceeds 50%. Exposure to high concentrations of carbon monoxide can be expected to cause death in minutes with almost no warning signs.

Carbon monoxide is obviously a substantial safety hazard. We all have small amounts of carbon monoxide circulating as carboxyhemoglobin in our blood from the normal catabolic breakdown of heme. In heavy smokers, the level of carboxyhemoglobin may reach 5% to 10% and in those suffering chronic exposure, (e.g., workers on highways, parking garages) the levels may result in pathologic changes from the hypoxia. Carbon monoxide at a level of 0.04% produces no measurable changes in the physiology while 0.35% can be fatal in 1 hour. First aid for carbon monoxide is to remove the victim to fresh air immediately which, while lifesaving, is only part of the story. In fresh air, assuming normal respiration is still present, the half life of carbon monoxide in the blood is on the order of 5 hours. With pure oxygen, the half life is on the order of 1 ½ hours. Carbon Monoxide should never be used without respirator equipment and pure oxygen available on site. The Safety Officer must approve the use of Carbon Monoxide.

In mass euthanasia situation, carbon monoxide would be very effective for all of the same reasons mentioned above that make it so dangerous for the operator. The major problem to be solved in a mass euthanasia situation is to have a completely closed airtight system with adequate gas scavenging equipment to ensure that there is minimal exposure to those handling animals and operating the system. Because the system must be completely closed, animals would have to be left in the chamber, exposed to the carbon monoxide, for extended periods of time to ensure death. Otherwise, even more time would be lost if the system was purged of carbon

monoxide only to discover that there were survivors. It would be necessary to close and recharge the system in order to euthanize them.

Large animals such as mature sows and boars or cattle would present problems of scale in having airtight chambers which are large enough to process more than one or two animals at a time. Processing only a few animals at a time would not be acceptable in a mass euthanasia situation.

The exhaust of a cold internal combustion engine is said to produce 5% to 7% carbon monoxide. An engine at normal operating temperatures produces less carbon monoxide and it is likely that modern computer controlled engines would also produce less under all operating conditions. Exhaust gasses contain so many other noxious combustion products that they should never be used in mass euthanasia. Exhaust gas is hot and would need special cooling equipment before animal exposure making it even more unsuitable as a euthanasia agent. In industry, carbon monoxide is produced by chemical reaction but the complexity of equipment necessary to deliver a pure gas makes this unsuitable to use in the field. Carbon monoxide is available in cylinders as an industrial gas. This is the only form that should be considered for euthanasia purposes.

Chapter 6 Euthanasia of Domestic Bovine

Three methods of humane euthanasia for domesticated breeds of bovine are specified in Part 313 of 9 CFR; *Humane Slaughter of Livestock*. These methods include captive bolt, gunshot, and electrical stunning/slaughtering. Although these procedures may need to be adapted for field conditions, they should be followed as closely as possible. With proper planning and preparation, all of these methods would be practical in the field situation for mass euthanasia.

The use of injectable anesthetics would be practical for very small numbers of bovine but the process will be necessarily slow because it requires prolonged individual handling and restraint. Injectable products are much more practical for the small ruminants primarily because the handling and restraint problems are minimal. The use of injectable products should always be strongly considered when animals have been hand raised (e.g., 4-H projects) particularly when the owner of a hand raised animal insists on being present during euthanasia.

From a practical handling point of view as well as a humane consideration, bovines must not be forced to move faster than normal walking speed and the use of electric prods or canvas slappers must be kept to a minimum. There is no excuse for using sharp pointed prods which will inflict pain. The animals must be restrained in a manner that does not elicit injury or undue pain. Animals which are handled in a rough or hurried manner will become excited and make their further handling unnecessarily difficult. As a humane consideration, down or disabled animals that can not get up and move on their own should be euthanized where they are and moved to the disposal site after death.

Penetrating Captive Bolt—Euthanasia of bovines by means of a penetrating captive bolt is both humane and efficient. Appropriate restraint must be used to ensure that the method is also relatively safe for personnel. The “aiming point” for the penetrating captive bolt when used on bovines can be located by drawing imaginary lines from each ear to the opposite eye. Where the lines intersect in the middle of the forehead is the proper entrance point. The end of the penetrating captive bolt device should be placed flat on the forehead of the animal so that the “bolt” is aimed toward the foramen magnum. With the head of the animal in a normal postural position, the weapon will be at approximately a 45° angle to the horizontal

While penetrating captive bolt and gunshot, when properly applied, are usually fatal, it is strongly recommended that an adjunct measure (e.g., exsanguination via carotid or brachial arteries or thoracotomy) be used to ensure rapid death and prevent the possibility of an animal that is stunned regaining consciousness. If an adjunct measure is not to be used, then a veterinarian or an individual specifically trained should inspect each animal to ensure clinical death.

Gunshot—Use of gunshot with species-appropriate ammunition is a conditionally acceptable method of euthanasia for bovines according to AVMA guidelines due to the potential for uncontrolled incidents. Factors to be considered in choosing suitable cartridges can be found in Chapter 5. Gunshot should be performed only by personnel with the appropriate skills, training,

and experience. Safety guidelines jointly developed and agreed to by local law enforcement and the AERO Safety Officer should be strictly followed.

In the case of firearms used at close range, the “aiming point” for entrance of the projectile is the same as for the penetrating captive bolt, see above. When used at close range to place a bullet through the brain of an animal, the firearm should NEVER be placed in contact with the head of the animal. Some automatic handguns will not fire if any pressure to the rear is put on the muzzle of the weapon. Excess gas and particles will exit between the cylinder and barrel of revolvers if the muzzle is obstructed by placing it against the animals head. In old animals and mature bulls the ossification of the skull may be adequate to deflect some projectiles. In these animals it is desirable to move the aiming point an inch to either side of the midline while maintaining the path of the projectile toward the foramen magnum.

When used at long range to kill cattle which can not otherwise be handled, another aiming point that can be used is half way between the eye and the base of the ear. The path of the projectile should cause it to exit through the same point on the opposite side of the skull if it has sufficient energy to exit.

If skull penetration problems become evident, it may be necessary to switch from simple hollow point or controlled expansion projectiles to a projectile like that in the Winchester Supreme® Failsafe® which has a solid copper alloy nose with a notched hollow point cavity and a lead core protected by a steel insert. It is engineered for deep penetration through thick, tough skin, heavy muscle tissue and bone. A round of this extreme penetrating ability should NOT be used for the average animal because ideally the spent projectile will never exit the animal but will expend all of its energy internally.

Electrocution—as a method of euthanasia, electrocution would be very difficult to apply to the bovine species in the field. The various things to be considered were covered in Chapter 5. The individual handling that would be necessary with adult bovine makes this an unwieldy technique that should only be considered if there is no other practical method available. Personnel who administer this form of euthanasia are advised to tranquilize or sedate each bovine before attempting to attach the electrodes for euthanasia. The electrodes must be positioned to ensure that the electric current passes directly through the brain to achieve stunning. This can be accomplished either by positioning the electrodes from ear to ear or from poll to muzzle. After stunning the electrodes would be repositioned to pass current through the heart and produce fibrillation. The electrodes would be positioned on the sides of the animal over the heart or on the anterior and posterior portions of the body.

Injectable Euthanasia Agents— general information has been adequately covered in Chapter 5. With mature bovines, the main problem is the sheer volume of agent which must be injected. An 1100 pound cow would require 110ml of euthanasia solution. If the instruction for the product were strictly followed (1ml/5sec) the 110ml would be injected over a period of more than 9 minutes to achieve the situation that is, “most comfortable to the animal.” Even injected at 10 times the recommended rate injection will still require a procedure time of one minute during which adequate restraint must be maintained to keep the needle in the vein and protect the operator. A crush gate is an excellent method for restraining the animal and preventing it from

falling on personnel as the anesthetic takes effect. Pre-anesthesia with 1ml xylazine IV is strongly recommended if injectable euthanasia agents are to be used. Strongly consider having two operators inject into the right and left jugular veins simultaneously using 18ga or larger needles. This will significantly decrease the period of time when excitability might cause restraint problems.

Chapter 7 Euthanasia of Domestic Sheep and Goats

Four methods of humane euthanasia for domesticated breeds of sheep and goats are specified in Part 313 of 9 CFR; *Humane Slaughter of Livestock*. For both species, these methods include captive bolt, gunshot, and electrical stunning/slaughtering; and for sheep only, carbon dioxide is designated and approved as a humane method. Although these procedures may need to be adapted for field conditions, they should be followed as closely as possible. With proper planning and preparation, all of these methods would be practical in the field situation for mass euthanasia.

The use of injectable anesthetics is a practical euthanasia method for sheep and goats. Injectable products are much more practical for the small ruminants than for the bovine species primarily because the handling and restraint problems are minimal. The use of injectable products should always be strongly considered when animals have been hand raised (e.g., 4-H projects) particularly when the owner of a hand raised animal insists on being present during euthanasia.

From a practical handling point of view as well as a humane consideration, sheep and goats must not be forced to move faster than normal walking speed and the use of electric prods or canvas slappers must be kept to a minimum. There is no excuse for using sharp pointed prods which will inflict pain. The animals must be restrained in a manner that does not elicit injury or undue pain. Animals which are handled in a rough or hurried manner will become excited and make their further handling unnecessarily difficult. As a humane consideration, down or disabled animals that can not get up and move on their own should be euthanized where they are and moved to the disposal site after death.

Penetrating Captive Bolt—Euthanasia of caprine and ovine species by means of a penetrating captive bolt is both humane and efficient. Appropriate restraint must be used to ensure that the method is also relatively safe for personnel. The “aiming point” for the penetrating captive bolt when used on sheep without horns should be the center of the top of the head with the bolt pointed straight down. In the case of horned sheep and goats, the weapon is placed immediately behind the ridge between the horns and angled to fire the bolt slightly forward toward the base of the tongue.

Gunshot—Use of gunshot with species-appropriate ammunition is a conditionally acceptable method of euthanasia according to AVMA guidelines due to the potential for uncontrolled incidents. Factors to be considered in choosing suitable cartridges can be found in Chapter 5. Gunshot should be performed only by personnel with the appropriate skills, training, and experience. Safety guidelines jointly developed and agreed to by local law enforcement and the AERO Safety Officer should be strictly followed.

In the case of firearms used at close range, the “aiming point” for entrance of the projectile is the same as for the penetrating captive bolt, see above. When used at close range to place a bullet through the brain of an animal, the firearm should NEVER be placed in contact with the head of the animal. Some automatic handguns will not fire if any pressure to the rear is put on the muzzle of the weapon. Excess gas and particles will exit between the cylinder and barrel of revolvers if

the muzzle is obstructed by placing it against the animals head. In mature horned sheep and goats the hardness of the skull may be adequate to deflect some projectiles. In these animals it is necessary to be very sure that the aiming point is behind the ridge between the horns. The path of the projectile should be angled slightly forward toward the base of the tongue as described for the captive bolt weapon. It should be noted that the brain in the mature goat is much further back than might be expected. With species unfamiliar to a shooter, proper orientation and instruction should include demonstration skull specimens that have been sawed lengthwise for clarity.

Electrocution—as a method of euthanasia would be difficult to apply to the caprine and ovine species in the field. The various things to be considered were covered in Chapter 5. The individual handling that would be necessary with these animals makes this an unwieldy technique that should only be considered if there is no other practical method available. Personnel who administer this form of euthanasia are advised to tranquilize or sedate each animal before attaching the electrodes for euthanasia. The electrodes must be positioned to ensure that the electric current passes directly through the brain to achieve stunning. This can be accomplished either by positioning the electrodes from ear to ear or from poll to muzzle. After stunning the electrodes would be repositioned to pass current through the heart and produce fibrillation. The electrodes would be positioned on the sides of the animal over the heart or on the anterior and posterior portions of the body.

Injectable Euthanasia Agents— general information has been adequately covered in Chapter 5. Sheep and goats are of such size that the volume of agent which must be injected becomes reasonable. A 300 pound animal would only require 30ml of euthanasia solution. If the instruction for the product were strictly followed (1ml/5sec) the 30ml would be injected over a period of 3 minutes to achieve the situation that is, “most comfortable to the animal.” Adequate restraint of even large specimens is reasonable to do by hand although the use of a crush gate will significantly reduce the stress on the operators over a long working day. Pre-anesthesia for restraint purposes should be unnecessary except under unusual conditions. Strongly consider having two operators inject into the right and left jugular veins simultaneously using 18ga x 1 ½” or larger bore needles. This will significantly decrease the period of time when excitability might cause restraint problems.

Carbon dioxide—can be used to euthanize sheep and will probably work equally well with goats although goats are not mentioned in 9 CFR 313.5. However, the extensive infrastructure necessary to handle a large number of animals makes it unlikely that this would be a suitable field method. If a slaughter plant is available that already has the necessary tunnels and equipment, this facility should be leased if possible. With careful planning, a truck or adequately tight room could be used as a chamber for carbon dioxide euthanasia.

Chapter 8 Euthanasia of Equine

Two methods of humane euthanasia for horses, mules, and other equines are specified in Part 313 of 9 CFR; *Humane Slaughter of Livestock*. These methods are captive bolt and gunshot. Although these procedures may need to be adapted for field conditions, they should be followed as closely as possible. With proper planning and preparation, these two methods would be practical in the field situation for mass euthanasia.

Although equine are not mentioned in 9 CFR 313.30, Electrical; stunning or slaughtering with electric current, the use of electrocution for equine is found to be humane in Title 7 United States Code, Chapter 48; Section 1902.

The use of injectable anesthetics would be practical for tractable equine but the process will be necessarily slow because it requires prolonged individual handling and restraint. Injectable products are much more practical for the young or small equine primarily because handling and restraint problems are somewhat reduced. The use of injectable products should always be strongly considered when dealing with equine that are privately owned. This would be particularly true if the owner of the animal were to insist on being present during euthanasia. Horses that are privately owned tend to be highly valued pets and their loss in a mass euthanasia situation would be particularly difficult for an owner.

Section 313 of 9 CFR makes the same provisions for the handling of all livestock. From a practical handling point of view as well as a humane consideration, equines must not be forced to move faster than normal walking speed and the use of electric prods or canvas slappers must be kept to a minimum. There is no excuse for using sharp pointed prods which will inflict pain. The animals must be restrained in a manner that does not elicit injury or undue pain. Equine particularly, when handled in a rough or hurried manner will become excited and make their further handling unnecessarily difficult.

Sedation—or tranquilization of equine is strongly recommended before euthanasia. If the horse can be approached safely, an IV dose of xylazine (.5mg/lb) will provide excellent sedation within 5 minutes which will last for 15 to 20 minutes fading gradually over the following half hour. If a horse can not be approached safely, a pole syringe can be used to administer xylazine IM (1mg/lb) which will provide sedation within 15 minutes lasting for at least an hour.

Penetrating Captive Bolt—Euthanasia of equine by means of a penetrating captive bolt, with adequate restraint, is considered humane and is an acceptable method to the AVMA panel. Some writers have raised the issue that the horse may rear and injure the operator before there is time to move away. If the penetrating captive bolt is to be used, adequate restraint to ensure operator safety is absolutely necessary. The “aiming point” for the penetrating captive bolt when used on equines can be located by drawing imaginary lines from each ear to the opposite eye. Where the lines intersect in the middle of the forehead is the proper entrance point. The end of the penetrating captive bolt device should be placed flat on the forehead of the animal so that the “bolt” is aimed toward the foramen magnum. With the head of the animal in a normal postural position, the weapon will be at approximately a 45° angle to the horizontal.

While penetrating captive bolt and gunshot, when properly applied, are usually fatal, it is strongly recommended that an adjunct measure (e.g., exsanguination via carotid or brachial arteries or thoracotomy) be used to ensure rapid death and prevent the possibility of an animal that is stunned regaining consciousness. If an adjunct measure is not to be used, then a veterinarian or an individual specifically trained should inspect each animal to ensure clinical death.

Gunshot—Use of gunshot with species-appropriate ammunition is a conditionally acceptable method of euthanasia for equines according to AVMA guidelines due to the potential for uncontrolled incidents. Factors to be considered in choosing suitable cartridges can be found in Chapter 5. Gunshot should be performed only by personnel with the appropriate skills, training, and experience. Safety guidelines jointly developed and agreed to by local law enforcement and the AERO Safety Officer should be strictly followed.

In the case of firearms used at close range, the “aiming point” for entrance of the projectile is the same as for the penetrating captive bolt, see above. When used at close range to place a bullet through the brain of an animal, the firearm should NEVER be placed in contact with the head of the animal. Some automatic handguns will not fire if any pressure to the rear is put on the muzzle of the weapon. Excess gas and particles will exit between the cylinder and barrel of revolvers if the muzzle is obstructed by placing it against the animals head. It is very unlikely that a skull penetration problem, and the need to use projectiles specifically engineered for extreme penetrating ability, would ever occur in the equine species.

When used at long range to kill horses which can not otherwise be handled, another aiming point that can be used is half way between the eye and the base of the ear. The path of the projectile should cause it to exit through the same point on the opposite side of the skull if it has sufficient energy to exit.

Electrocution—as a method of euthanasia, electrocution would be difficult to apply to the equine species in the field. The various things to be considered were covered in Chapter 5. The individual handling that would be necessary with equine makes this an unwieldy technique that should only be considered if there is no other practical method available. Personnel who administer this form of euthanasia are advised to tranquilize or sedate each animal before attempting to attach the electrodes for euthanasia. The electrodes must be positioned to ensure that the electric current passes directly through the brain to achieve stunning. This can be accomplished either by positioning the electrodes from ear to ear or from poll to muzzle. After stunning the electrodes would be repositioned to pass current through the heart and produce fibrillation. The electrodes would be positioned on the sides of the animal over the heart or on the anterior and posterior portions of the body.

Injectable Euthanasia Agents— general information has been adequately covered in Chapter 5. With mature equines, the main problem is the sheer volume of agent which must be injected. A 1000 pound horse would require 100ml of euthanasia solution. If the instruction for the product were strictly followed (1ml/5sec) the 100ml would be injected over a period of more than 8 minutes to achieve the situation that is, “most comfortable to the animal.” Even injected at 10

times the recommended rate injection will still require a procedure time of one minute during which adequate restraint must be maintained to keep the needle in the vein and protect the operator. Sedation as mentioned above is highly recommended. Strongly consider having two operators inject into the right and left jugular veins simultaneously using 18ga x 1 ½" or larger bore needles. This will significantly decrease the period of time when excitability might cause restraint problems.

9 Euthanasia of Swine

Four methods of humane euthanasia for swine are specified in Part 313 of 9 CFR; *Humane Slaughter of Livestock*. These methods include carbon dioxide, captive bolt, gunshot, and electrical stunning/slaughtering. Although these procedures may need to be adapted for field conditions, they should be followed as closely as possible. With proper planning and preparation, all of these methods would be practical in the field situation for mass euthanasia.

The use of injectable anesthetics is a less practical euthanasia method for swine since the process requires prolonged individual handling and restraint. Injectable products are much more practical for the small porcine than for the adults because the handling and restraint problems are minimal for the young animals. The use of injectable products might be considered when animals have been hand raised (e.g., 4-H projects) particularly when the owner of a hand raised animal insists on being present during euthanasia.

From a practical handling point of view as well as a humane consideration, swine must not be forced to move faster than normal walking speed and the use of electric prods or canvas slappers must be kept to a minimum. There is no excuse for using sharp pointed prods which will inflict pain. The animals must be restrained in a manner that does not elicit injury or undue pain. Animals which are handled in a rough or hurried manner will become excited and make their further handling unnecessarily difficult. As a humane consideration, down or disabled animals that can not get up and move on their own should be euthanized where they are and moved to the disposal site after death.

Euthanasia must be performed by competent personnel trained and experienced in swine euthanasia methods according to guidelines established by the Safety Officer.

Carbon dioxide—can be used to euthanize swine. It has been used extensively in the slaughter industry for stunning as well as in the Accelerated Pseudorabies Eradication Program (APEP) for euthanasia. However, the extensive infrastructure necessary to handle a large number of animals makes it unlikely that this would be a suitable field method unless transportation arrangements could be devised to move animals to a central location. The National Pork Board and American Association of Swine Veterinarians recommend carbon dioxide only for smaller swine (i.e., weighing up to 70 lbs or 32 kg) (See these organizations' joint publication "On Farm Euthanasia of Swine—Options for the Producer," at www.aasp.org). The weight limitation is applied because they do not consider euthanasia of larger animals with carbon dioxide to be practical for the producer in the farm situation. If a slaughter plant is available that already has the necessary tunnels and equipment for CO₂ stunning, this facility should be leased if possible. With careful planning, a truck or adequately tight room could be used as a chamber for carbon dioxide euthanasia.

In cases in which asphyxiant or toxic gas is used, personnel must be provided with appropriate safety training. Suitable respirator equipment (e.g., a self-contained breathing apparatus and oxygen equipment) should be available on site. All equipment must be utilized according to guidelines established by the Safety Officer.

Penetrating Captive Bolt—Euthanasia of swine by means of a penetrating captive bolt is both humane and efficient. Appropriate restraint must be used to ensure that the method is also relatively safe for personnel.

Aiming the Penetrating Captive Bolt—it is essential to aim the penetrating captive bolt correctly. In “On Farm Euthanasia of Swine—Options for the Producer,” the National Pork Board and American Association of Swine Veterinarians recommend the following: “The penetrating captive bolt should be placed very firmly against the skull and directed upward approximately 20 ° toward the brain. A charge large enough to cause the bolt to penetrate the skull of a sow or boar should be used (0.22 3gr Green cartridge).” The green cartridge mentioned in this quote has the largest powder charge and greatest penetrating ability available in the various cartridges used to power the specific captive bolt weapon being used. Not all captive bolt weapons use variable charges. A more powerful .25 caliber cartridge is now in common use in captive bolt weapons.

Use of Adjunct Euthanasia Methods with Penetrating Captive Bolt—many variables can affect the energy which a captive bolt imparts to the skull to produce unconsciousness or death in an animal. Some of these variables include the propellant charge being used, how clean the weapon is, if the weapon is properly lubricated, and the precision with which the operator aims the weapon. Accordingly, the National Pork Board and American Association of Swine Veterinarians recommend use of an adjunct method (e.g., exsanguination by severing the brachial or carotid artery) to assure rapid euthanasia.

Gunshot—Title 9 of the CFR, Part 313, approves the use of gunshot as a slaughter method for swine, stating that “...firearms shall be employed in the delivery of a bullet or projectile into the animal...so as to produce immediate unconsciousness in the animal by a single shot” and “...with a minimum of excitement and discomfort.” Use of gunshot with species-appropriate ammunition is a conditionally acceptable method of euthanasia for swine according to AVMA guidelines due to the potential for uncontrolled incidents. Factors to be considered in choosing suitable cartridges can be found in Chapter 5. Gunshot should be performed only by personnel with the appropriate skills, training, and experience. Safety guidelines jointly developed and agreed to by local law enforcement and the AERO Safety Officer should be strictly followed.

In the case of firearms used at close range, the “aiming point” for entrance of the projectile is the same as for the penetrating captive bolt, see above. The operator should be aware that the swine brain is located very high when considering the total mass of the skull. Persons unfamiliar with the anatomy of the swine skull should receive instruction with sectioned swine heads. When used at close range to place a bullet through the brain of an animal, the firearm should NEVER be placed in contact with the head of the animal. Some automatic handguns will not fire if any pressure to the rear is put on the muzzle of the weapon. Excess gas and particles will exit between the cylinder and barrel of revolvers if the muzzle is obstructed by placing it against the animal's head. With large adult swine it is likely that a skull penetration problem, and the need to use projectiles specifically engineered for extreme penetrating ability will occur so personnel need to be alert for this possibility.

When used at long range to kill swine which can not otherwise be handled, another aiming point that can be used is half way between the eye and the base of the ear. The path of the projectile should cause it to exit through the same point on the opposite side of the skull if it has sufficient energy to exit. The fact that the temporal bones are thinner and can be penetrated more easily may be a consideration when dealing with adult swine.

Electrocution—as a method of euthanasia, electrocution has been used very successfully during the APEP operations. The use of equipment from a supplier that provided electrical devices for the slaughter industry ensured the success of this technique. A complete discussion of electrocution is included in Chapter 5.

Injectable Euthanasia Agents—general information regarding injectable euthanasia agents has been adequately covered in Chapter 5. The major problems with using injectable euthanasia agents in mature swine are that a relatively large volume of solution is required and suitable veins are not as readily accessible as with other species. A 500 pound sow or boar would require 50ml of euthanasia solution. If the instruction for the product were strictly followed (1ml/5sec) the 50ml would be injected over a period of more than 4 minutes to achieve the situation that is, “most comfortable to the animal.” Even at 10 times the recommended rate, injection would require a procedure time approaching one minute during which adequate restraint must be maintained to keep the needle in the vein and protect the operator.

Sedation of swine over 250lbs would be highly desirable if it were practical because larger animals are very difficult to physically restrain. While these animals can be sedated with ketamine, a suitable dose for restraint is in the range of 5 to 10mg/lb IM. Since ketamine is normally supplied as a concentration of 100mg/ml it would require from 12 to 25ml for a 250lb animal. This dose must be placed in a muscle mass and not in fat. If the swine can be restrained adequately to inject into an ear vein, ketamine dosed at 2 – 5mg/lb can be used for sedation. Note that xylazine which has been recommended for sedation in many of the other domestic species is not effective in swine.

In animals over 100 lbs it is strongly suggested that euthanasia solution be injected into the anterior vena cava. This technique requires that a 6” x 18ga hypodermic needle be inserted through the thoracic inlet beginning low in the right jugular fossa and pointed toward the caudal margin of the left shoulder blade. Draw back on the plunger and observe that there is a free flow of blood to be absolutely sure that the needle is in the lumen before injecting.

10 Euthanasia of Poultry and Birds

Part 313 of 9 CFR; *Humane Slaughter of Livestock* provides no guidance regarding the slaughter of poultry which are defined separately from livestock throughout 9 CFR. Likewise, Title 7 United States Code, Chapter 48; Section 1902 makes no mention of poultry. Part 381.65 of 9 CFR, states briefly that, “Poultry must be slaughtered in accordance with good commercial practices...” For pet birds, euthanasia must be performed in a manner that is humane, safe for personnel, and not aesthetically displeasing to the people observing (or performing) the procedure.

As required for the mammalian species, euthanasia must be performed by competent personnel trained and experienced in species-specific euthanasia methods. The animals must be restrained in a manner that does not elicit injury or undue pain. If the method used is dangerous to the operator then the operation must be carried out according to guidelines established by the Safety Officer.

Injectable Euthanasia Agents—if only a few pet birds require euthanasia, an intraperitoneal injection of nonirritating euthanasia agent is an acceptable method. You can expect it to require an extended period of time for absorption of the chemical from the peritoneal cavity. Ketamine Hydrochloride can be used to provide restraint in pet or aviary birds if necessary. The dose in the range of 20-50mg/Kg IM should be adequate.

Carbon dioxide—can be used to euthanize poultry and pet birds. It has been used extensively in mass euthanasia situations during past disease eradication programs. Because of the size of most poultry and birds it is possible to euthanize small numbers in 40-gallon covered containers of plastic or metal. Larger numbers can be herded into an area where they can be covered with plastic sheeting to contain the gas for euthanasia. When very large numbers of poultry must be euthanized, large roll-off dumpsters can be positioned outside the poultry house, covered with plastic or tarpaulins, filled with carbon dioxide and loaded with the poultry. In all cases, the container must be covered to trap the carbon dioxide and prevent mixing with air.

The use of Nitrogen or Argon gases is somewhat more problematic because the specific gravity of these gases are very near that of room air and they will not remain in the bottom of an open container as readily as carbon dioxide will. To be acceptable, Nitrogen or Argon must be used in a completely closed (gastight) system and Oxygen must be less than 2% to ensure rapid loss of consciousness. Further information regarding use of gas is located in Chapter 5.

In cases in which asphyxiant or toxic gas is used, personnel must be provided with appropriate safety training. Suitable respirator equipment (e.g., a self-contained breathing apparatus and oxygen equipment) should be available on site. All equipment must be utilized according to guidelines established by the Safety Officer.

Cervical dislocation—the practice of cervical dislocation for euthanasia of poultry should only be performed by well trained individuals who are proficient with the technique. During training of personnel to perform this technique, the poultry should be sedated heavily or anesthetized prior to the training exercise. Carbon dioxide in a suitable container should be used for

anesthesia. Cervical dislocation is reasonable to use when there are very small numbers of poultry being euthanized or when tissues are being collected.

Decapitation—the use of decapitation for euthanasia of poultry, while accepted as a humane method, can not be recommended on at least three counts. First, it is unnecessarily messy, second, it appears brutal to onlookers, and third, it is inefficient since each bird must be handled individually. Unless there is a need for exsanguination of the carcass for some reason having to do with the collection of tissue samples or salvage of the carcass for food, other methods of euthanasia are preferred.

Electrocution—as a method of euthanasia, electrocution has been used very successfully with poultry. The use of equipment from a supplier that provides electrical devices for the slaughter industry ensured the success of this technique. At least two private developers have built euthanasia equipment utilizing electrocution in the hope of proving it during a disease eradication operation. A complete discussion of electrocution is included in Chapter 5.

Gunshot—when euthanasia of small numbers of feral or wild birds becomes necessary and they can not be moved into a building or otherwise trapped; the use of shotguns with shot size appropriate to the size of the birds can be used. This is not a suitable method when any large numbers of birds are involved.

11 Euthanasia of Captive Ruminants, Wild, Exotic, and Zoo Animals

In the case of zoo or game park animals, consult with expert handlers from a recognized facility, institution, agency, or association before selecting a euthanasia method. When the animals closely resemble the domestic animals covered in Chapters 6 through 10, consider the methods discussed in those chapters as a starting point in devising humane euthanasia methods.

Euthanasia must be performed by competent personnel trained and experienced in species-specific euthanasia methods. The Safety Officer should be consulted where handling the animals may cause significant danger to the personnel. In all cases, the animals must be restrained and handled in a manner that does not cause injury or undue pain.

The procedures and facilities used for the restraint and euthanasia of these animals must be humane and compatible with the needs of the species involved.

Gunshot—if it is not feasible to capture and restrain the species of animal to be euthanized, gunshot may be the only practical option. See the specific guidelines on the selection of firearms and ammunition provided in Chapter 5.

Injectable Euthanasia Agents—a wide variety of projectile equipment (e.g., Palmer Cap-Chur) utilizing very powerful restraint agents (e.g., Etorphine hydrochloride or M99) is in the hands of veterinarians specializing in zoo animal practice. If this equipment and these agents are to be used, hire the veterinarians with the specific specialized training to utilize them safely. Under no conditions should a product like M99 be used without having the specific antidote (e.g., Diprenorphine or M 50-50) available for immediate use in case of an accident.

A pole syringe or stick syringe can be effectively used at a distance to safely deliver an IM dose of a drug used for restraint in an unruly animal. In a somewhat more controlled situation, a hand syringe may be used, but it should be metal or plastic to avoid breakage if it is knocked from the hand. When using a syringe, in a situation where rapid delivery of the drug is critical, use an 18ga one-inch Luer-Loc needle tightened securely to the syringe.

A commercial or homemade blowgun is an effective delivery system for small quantities of drug out to a distance of about 40 feet. Commercial syringes are available for use in blowguns and homemade syringes utilizing propane as a propellant have been described in the professional journals.

Ketamine hydrochloride can be effectively used as a restraint agent delivered as an oral dose. Fill a syringe with two or three times the normal IM dose, and spray it into the mouth of the animal to be restrained.

References

Agriculture and Resource Management Council of Australia and New Zealand. "Operational Procedures Manual: Destruction" (AUSVETPLAN, ed. 2.0). Commonwealth of Australia and each of its States and Territories, 1996.

American Veterinary Medical Association. "2000 Report of the AVMA Panel on Euthanasia" (www.avma.org; click on "2000 Euthanasia Report"). Journal of the American Veterinary Medical Association, Vol. 218, No. 5, March 1, 2001.

Animal and Plant Health Inspection Service, U.S. Department of Agriculture. "Drug Enforcement Administration (DEA) Numbers and the Use of Controlled Substances (Euthanasia Solutions)." Veterinary Services Memorandum 583.1. September 27, 1994.

Blood, D.C., and V. P. Studdert. "Saunders Comprehensive Veterinary Dictionary." London: W.B. Saunders, 1999.

Murray E. Fowler, "Zoo and Wild Animal Medicine" W. B. Saunders Company, 1986

Acronyms

AERO—Animal Emergency Response Organization

APHIS—Animal and Plant Health Inspection Service (www.usda.aphis.gov). An agency of the U.S. Department of Agriculture

CDC—the U.S. Centers for Disease Control and Prevention. An agency of the U.S. Department of Health and Human Services.

EPA—Environmental Protection Agency

FAD—Foreign animal disease

FMJ—Full metal jacket

NAHEMS—National Animal Health Emergency Management System

NIOSH—National Institute for Occupational Safety and Health. Part of the U.S. Centers for Disease Control and Prevention.

TDD—Telecommunications device for the deaf

USDA—United States Department of Agriculture (www.usda.gov)

VS—Veterinary Services. A unit of the Animal and Plant Health Inspection Service

Glossary

Animal Emergency Response Organization (AERO)—A locally/State-based, nationally coordinated model, based on the Incident Command System, for responding to animal health emergencies.

Air embolism—an artery blockage resulting from the injection of air into the veins. Air embolism is not recommended as a method of euthanasia.

Bovine—common domestic cattle and other members of the Family Bovidae.

Caprine—pertaining to goats, members of the Family Capridae.

Cervical dislocation—a method of euthanasia in which the spinal cord is severed by dislocation of cervical vertebrae.

Contact premises—premises that an epidemiologist has determined to be related by sound epidemiological evidence to a known infected premises, also referred to as an exposed premises.

Exposed premises—premises that an epidemiologist has determined to be related by sound epidemiological evidence to a known infected premises, also referred to as contact premises.

Decapitation—removal of the head

Euthanasia—the deliberate ending of an animal's life in a manner that causes minimal pain and distress.

Euthanize—the act of performing euthanasia.

Exotic—Not native or indigenous to a country.

Exsanguination—the process of draining or losing blood as a result of internal or external hemorrhage

Hypovolemia—a decreased amount of circulating blood

Hypoxia—Diminished availability of oxygen to bodily tissues.

Inhalant—Taken into the body through the respiratory system.

Ovine—pertaining to sheep and other members of the Family Ovidae

Penetrating captive bolt—a firearm used for euthanasia in which a rod that is a permanent part of the weapon is driven through the skull, damaging the brain.

Poll—the top of an animal's head or occiput

Surgical anesthesia—a state in which the animal feels no painful sensation (9 CFR 313).

Venipuncture—Surgical puncture of a vein (e.g., for blood withdrawal or intravenous medication).

**Appendix I
Sample Personnel
Orientation Factsheet**

Biosecurity: DOs and DON'Ts*

Before ENTERING a premises,

DO:

- Park your vehicle away from site production facilities and/or ensure that your vehicle's tires, wheel wells, and undercarriage have been cleaned with soapy water so they are free of dirt and debris and/or that your vehicle has been taken through a pressure car wash.
- Designate a "clean" area in your vehicle—usually the passenger compartment. Keep it separate from the "dirty" area—usually the trunk or cargo area.
- Put on clean coveralls, boots, hat, gloves, and other apparel and use only clean equipment and supplies.
- Wash your hands with soap and water.
- Consult with the owner to identify an arbitrary line on the site demarcating a "clean" side and a "dirty" side.

DON'T:

- Enter a site's or vehicle's "clean" area unless you have disposed of or cleaned and disinfected all clothes, footwear, hats, gloves, equipment, supplies, and other sources of pathogen transmission.
- Attempt to disinfect a surface unless it first has been thoroughly cleaned (i.e., so it is free of visible organic material).
- Drive your vehicle on a premises any more than necessary. An on-site vehicle should be used for on-site transportation whenever possible.

**Note:* Additional biosecurity and cleaning/disinfection procedures are required to address the risks posed by serious zoonotic diseases.

(continued)

Biosecurity: DOs and DON'Ts

(continued)

Before LEAVING a premises,

DO:

- After returning to the vehicle area, use a brush and approved disinfectant to clean and disinfect all reusable clothing and equipment thoroughly—including personal items such as eyewear and jewelry. If these items are harmed by disinfectant, they may be washed thoroughly with soap and water or—if an acid-susceptible virus such as foot-and-mouth disease is involved—dipped in vinegar (acetic acid).
- Clean vehicle exteriors and trailers—including tires, wheel wells, and undercarriages—with soapy water so they are free of dirt and debris and/or take them through a pressure car wash.
- Place disposable coveralls (turned “inside out”), boots, and other soiled items in a plastic garbage bag to be left with the owner or placed in the “dirty” area of your vehicle.
- Dispose of the disinfectant solution according to label instructions.
- Dispose of all plastic garbage bags containing soiled supplies in a manner that prevents exposure to other people or animals.
- Wash your hands with soap and water.
- Clean and/or launder all reusable clothing and equipment.
- At the end of the day, take a shower. Personal hygiene should include shampooing your hair, cleaning under your fingernails, and clearing your respiratory passages by blowing your nose, clearing your throat, expectorating into a sink with running water, and washing your hands with soap and water.

DON'T:

- Bring “dirty” paperwork into the clean area of your vehicle.
- Visit another susceptible site until 12 hrs have passed.*

**Note:* The minimum waiting period of 12 hrs applies only to official animal health emergency personnel who follow biosecurity procedures on their premises visits. For other premises visitors, the minimum waiting period is 5 days.