Chapter 10: Guidelines for Swine Husbandry

FACILITIES AND ENVIRONMENT

Swine may be kept and readily adapt to a variety of production systems (*Pork Industry Handbooks,* undated and 1978 to present; MWPS, 1983; Baxter, 1984; Whittemore, 1993). The level of management applied in each viable system determines how much comfort the swine experience. More stockmanship may be necessary to meet pigs' needs in certain systems. Specific attention should be paid to management of effective environmental temperature (Table 10-1), exposure to sun, ventilation, vapor pressure, floor condition, area per pig, manure management, and quantity and quality of feed and water.

A predictable daily management routine allows pigs to develop a routine of their own. Animal care personnel should plan for swine management under climatic extremes and emergency conditions; personnel should be able to provide appropriate husbandry to minimize environmental stressors and animal distress. Animal care staff should be familiar with the behavior of normal pigs and of pigs experiencing stress or reduced well-being in order to improve pig comfort effectively when needed.

Attention should be given to pig dunging and resting preferences during both the design phase and the daily operation of swine facilities. Movement of manure and urine between pens should be minimized. Similarly, animal care personnel should take necessary precautions to prevent transmission of pathogens between pens and between facilities, even at the same location. Buildings should be periodically sanitized and disinfected.

Lighting

The domestic pig is less sensitive to its photic environment than are some other species. In the wild, swine do not depend on vision as much as on other sensory systems (Kilgour, 1985). When able to control the photoperiod for themselves, pigs prefer some light and some dark every hour of the day and night (Baldwin and Meese, 1977); their apparent light-dark cycle preference is not similar to any natural situation.

No particular daily photoperiod is necessary for growing pigs (Berger, 1980). Developing breeding animals may benefit from photoperiods with long days (e.g., 16 hr light:8 hr dark), although results are still largely inconclusive (Zimmerman et al., 1980; Wheelhouse and Hacker, 1982). Lactating sows respond positively to photoperiods of 16 hr light:8 hr dark, resulting in enhanced piglet performance, and these sows may return to estrus sooner (Mabry et al., 1982, 1983; Stevenson et al., 1983).

FEED AND WATER

Pigs should be observed, and their well-being should be assessed, at least twice each day. Feeders and waterers should be checked to be sure they are functional. Feeders and waterers should allow easy access by swine with minimal waste of feed. Feeders or feeding places should be free from manure, urine, and other contaminants. Pigs may be fed from the floor as long as the surface is dry and clean and individual feed consumption is not limited by social competition. A water medicator may be used for management of enteric infections. When feed is delivered to animal houses and to individual pens, care should be taken to minimize dust.

Pigs should be fed to meet or to exceed nutrient requirements as determined by the NRC (1988). Water should be available for ad libitum intake, and special care should be taken to ensure that water is accessible for each size of pig.

SOCIAL ENVIRONMENT

Pigs by nature are social animals. Young pigs show behavioral and physiological signs of stress when held in complete isolation from other pigs. The precise relationship between group size and pig performance is neither predictable nor clear (Livingston et al., 1969; Patterson, 1985). Growing pigs are commonly found in group sizes from 2 to 30 pigs per pen, but even in groups of hundreds per pen.

Adult sows are often found in groups in nature, except for before and after parturition, when they seek isolation. In agricultural settings, holding sows in social groups may result in domination of subordination and may lead to excessive stress or trauma to individual sows. Feral boars are usually solitary animals, except during the breeding season. Thus, in some cases, adult pigs housed individually may experience less stress than growing pigs would. Agricultural research that proposes to house growing pigs individually or in isolation from other swine should be approved by the ACUC. Routine, total isolation should be avoided, but individual housing with at least some social contact (olfactory, some tactile) is acceptable. Short periods of total isolation (e.g., during transportation) may be unavoidable.

Table 10-1. Recommended Thermal Conditions for Swine Used in Agricultural Research and Teaching.

Type and weight	Preferred range[a]	Lower extreme[b]	Upper extreme[c]
Lactating sow and litter	15 to 26°C (59 to 79°F) for sow; piglets have 32°C (90°F) minimum creep area	25°C (77°F) creep area 15°C (60°F) sow area	32°C (90°F) for sow; no practical upper limit for piglets
Prenursery, 3 to 15 kg (7 to 33 lb)	26 to 32°C (79 to 90°F)	15°C (59°F)	35°C (95°F)
Nursery, 15 to 35 kg (33 to 77 lb)	18 to 26°C (64 to 79°F)	5°C (41°F)	35°C (95°F)
Growing, 35 to 70 kg (77 to 154 lb)	15 to 25°C (59 to 77°F)	–5°C (23°F)	35°C (95°F)
Finishing, 70 to 100 kg (154 to 220 lb)	10 to 25°C (50 to 77°F)	–20°C (4°F)	35°C (95°F)
Sow or boar, >100 kg (>220 lb)	10 to 25°C (50 to 77°F)	–20°C (4°F)	32°C (90°F)

[a]Based on values given by NRC (1981), DeShazer and Overhults (1982), Curtis (1985), and Hahn (1985).

[b]Values represent lower extremes in air temperature when pigs are held in groups. Bedding is recommended when air temperature approaches the lower extreme.

[c]Except for brief periods, above these air temperatures, cooling should be provided by means such as evaporatively cooled air for growing pigs or a water drip for lactating sows.

HUSBANDRY

Biosecurity

Teaching and research facilities must often strike a compromise between public access and minimizing the entry of disease organisms. Establishing a barrier between pigs and visitors requires visitors to do some or all of the following: shower in, wear clean footwear, change to on-site clothes, and wear only on-site clothes.

A herd health program should be in place, and attention should be given to isolating (30 to 60 days) and retesting of new stock, vaccination, sanitation, and minimum exposure to pathogens. Appropriate vaccinations should be administered in accordance with manufacturer guidelines and government regulations. For preparturient sows, vaccines should be administered early enough in advance of parturition, and according to the label on the vaccine, to allow accumulation of specific antibodies in the colostrum. Growing pigs should be vaccinated based on herd health needs.

To reduce interbuilding transmission of pathogenic microorganisms, careful attention should be given to traffic patterns of interbuilding personnel and disease organisms in feeds and transport vehicles. Barriers to microorganism transmission should be considered for personnel who move between houses, including showering in, changing clothes, and the use of disinfectant footbaths as personnel move between houses. Animal care personnel in swine research and teaching facilities should not be in contact with swine elsewhere unless strict biosecurity precautions are followed.

Farrowing Systems

Sow Management. Some degree of confinement of the periparturient sow is both necessary and preferred by sows (Phillips et al., 1991). Even in extensive housing systems, sows should be provided with a small house or pen in which they can be detained and from which groupmates can be excluded. During farrowing, sows should be isolated from physical contact with other mature animals.

The presence of a caretaker during parturition is not mandatory; however, this component of the system should be included in the planning phase of the research or teaching operation. Floor space recommendations are in Table 10-2.

Indoor farrowing environments should be cleaned, disinfected, and dried before the preparturient sow is allowed to enter. Outdoor farrowing environments should be either treated as just described or subjected to several days of rest and sunshine between farrowing groups. Sows may be treated to eliminate internal and external parasites before being allowed to enter the farrowing area. Laxative additives or a specially formulated diet may be fed before and after parturition to minimize constipation.

During hot weather (daily maximum temperature above 32°C [90°F]), sows should be zone-cooled. This cooling may be accomplished by dripping water directly on the sow's shoulders, by providing directed currents of air (snout coolers), or, in extensive systems, by allowing sows to wet themselves with water or mud.

Litter Management. Piglets require special attention because they are born with low reserves of energy and immunoglobulin, thermoregulate poorly, and are vulnerable to being crushed. Until weaning, piglets should be provided with an area that is warm, dry, draft-free, and

zone-heated, and piglets should be protected from being crushed or injured by the sow.

The lower critical temperature of the piglet is about 35°C (95°F) at birth. However, the entire space in the house should not be heated to an air temperature even approaching the lower critical temperature of the piglets because the sow will become heat-stressed. Zone-heating, zone-cooling, or both, should be provided to meet the disparate thermal needs of the sow and piglets.

Any of the following procedures may be performed on piglets within a few days after birth: navel disinfected (if farrowing attended); needle teeth trimmed with a disinfected sharp device; tail trimmed to no less than 2.5 cm (1 in) from the body with a disinfected device (if piglets are to be raised indoors); supplemental iron injected (if piglets are to be nursed indoors); and individual identification made (usually ear notches).

Farrowing Pens and Crates. Extensive farrowing environments are acceptable research and teaching models when they are managed to minimize discomfort to piglets and sows. Sows kept outdoors should be observed regularly; bedding should be provided unless the thermal environment is adequate; fences should be sturdy and well-constructed. Electrified wire may be used. Proper health care for sows and piglets should be provided, and feces and urine should be removed periodically from such systems as needs arise. Sows and litters kept outdoors should be rotated among pastures to avoid accumulation of pathogens and parasites.

A farrowing house or pen should be cleaned and disinfected before each use. If sows farrow outdoors, appropriate sanitation procedures (e.g., moving huts and burning bedding) should be followed to ensure a clean farrowing environment. When supplemental zone-heating is not provided, farrowing houses on pasture and pens in central farrowing houses should be bedded with a suitable material such as straw. Bedding should be kept reasonably dry by the addition of more bedding material and by partial removal of soiled bedding at regular intervals as needed.

A typical farrowing pen measures at least 1.5 × 2.1 m (5 × 7 ft), but often is 3 × 3 m (10 × 10 ft). A protected area should be provided for piglets (at least .8 m^2 [8 ft^2]). This area should have supplemental heat (e.g., a 250-W heat lamp). Care should be taken to prevent thermal burns from supplemental heat sources. Guard rails should be placed on the perimeter of indoor pens to prevent the sow from crushing piglets against the wall.

Certain farrowing pens may accommodate acceptable piglet survival, including outdoor pasture systems with English-style farrowing arcs (Thornton, 1988; Edwards, 1995; McGlone et al., 1995) and pens with sloped floors for indoor sows (Collins et al., McGlone and Morrow-Tesch, 1990).

To reduce piglet injury and protect animal care personnel from overly aggressive periparturient sows, indoor sows may be confined in farrowing crates or free stalls from day 109 of gestation until the piglets are weaned (Curtis et al., 1995). A farrowing sow unit typically measures 1.5 × 2.1 m (5 × 7 ft), but the sow resides in a crate within that area that typically measures .6 × 2.1 m (2 × 7 ft) (Curtis et al., 1989). To lie down, sows slide along the restraining walls, which reduces piglet deaths. In addition, each sow and litter in a crate or pen can receive individual attention.

With few exceptions, the floors under or to the rear of the sow zone in farrowing crates are slotted or perforated. In this way, sows and piglets are effectively and quickly separated from their excreta, and the environment dries quickly. Acceptable types of slotted floors include perforated metal, woven metal, plastic-coated metal, metal bars, fiberglass, concrete, and combinations of materials. The floor surface should be unabrasive, nonporous, and not slippery (Fritschen and Muehling, 1984). Slots between slats should be wider behind the sow (usually 2.5 cm [1 in]) to allow passage of excreta. These wider slot openings should be covered during parturition to enable piglets to walk easily. Narrower perforations or slots prevent piglets from getting their feet caught in the floor openings. Rubber mats may be provided in the creep area for the first few weeks. Floor materials should be free of exposed or projecting materials to avoid injury to the leg, foot, or hoof. Bedding should be provided for farrowing crates equipped with solid floors.

Nursery Systems

Nursery systems include those housing and management arrangements for newly weaned pigs. Typically, pigs reside in a nursery from weaning until 8 or 9 wk of age. This period in the life of the pigs is critical because diet and environment change markedly when the pigs move to the nursery. Weaning at night may be less stressful than weaning during the early morning (Ogunbameru et al., 1992).

Piglets may be weaned at any age, but the younger the piglets are at weaning, the greater is the need for specialized facilities, care, a high degree of sanitation, and high quality diets (Lecce, 1986; Owen et al., 1995). Segregated early weaning is an emerging technology to improve pig health and well-being in herds with chronic disease. In a segregated early weaning system, piglets are weaned at 10 to 20 days of age and then transported to a facility that is geographically separated from other swine facilities (Dewey, 1995). This technology reduces the transfer of disease microorganisms from sows to nursery pigs by removing piglets from the sow before passive immunity decreases. The effects of early weaning on behavior of sows and piglets have not been evaluated fully, but benefits of properly executed segregated early weaning procedures include increased weight gain, improved feed efficiency, decreased morbidity, decreased mortality, and lower overall use of medication. Early weaned sows have subsequent reproductive delays, and piglets may have suppressed immunity (Hennessy et al., 1987) and may show excessive navel sucking and belly rubbing. If a disease microorganism is present in a segregated early weaning system, piglet morbidity and mortality may be very high.

The lower critical temperature of a 4-wk-old piglet (once it is eating at the rate of approximately 3 to 3.5 times thermoneutral maintenance) is around 26°C (79°F) (Table 10-1); therefore, most nurseries should be equipped with supplemental heating equipment. Exceptions to this are when piglets continue suckling (and thus obtaining heat from) the sow beyond 3 wk of age or when deep bedding is used to create a microenvironment in the range of thermoneutrality. In addition to supplemental heat, nursery houses should be maintained at a higher degree of sanitation than is required for older pigs. Nurseries should be operated on an all-in, all-out basis, and the facility should be cleaned, disinfected, and dried thoroughly between groups of pigs.

Weaned pigs should be self-fed a nutritionally complete and balanced diet unless the experimental protocol dictates otherwise (NRC, 1988). Up to 4 pigs may share a single proper feeding space. Pigs should be provided ad libitum access to clean water. One watering device is needed per 10 to 20 pigs and at least two watering devices per pen located far enough apart that one pig cannot dominate both. Floor area recommendations are in Table 10-2.

Slotted floors are common in nurseries. Flooring material may be similar to that in farrowing crate units. Pens with solid floors should be bedded with straw or a material with similar thermal and absorbent properties. If partially slotted floors are used, the waterer should be located over the slots.

Growing and Finishing Systems

The growing-finishing stage refers to pigs from 8 or 9 wk of age to market weight age of about 20 to 25 wk, or 100 to 125 kg (220 to 275 lb). The management of growing and finishing pigs differs from weanling pigs in that a lower standard of sanitation is required, units may be run with a continuous flow of pigs, and older pigs can tolerate a much wider range of environmental temperature than younger pigs (Table 10-1). Although growing-finishing systems may use a continuous flow of pigs, an all-in, all-out system is preferred.

Typically, growing and finishing pens are rectangular and contain no more than 40 pigs. Up to 10 pigs may share a feeder space, and up to 20 pigs may share a waterer. Specialized feeding and watering equipment may accommodate different pig densities. Penning materials should be sturdier than those used in nurseries. Floor area recommendations are in Table 10-2. Although needs for floor space are less well-defined for heavy weight finishing pigs, more floor space per pig is needed as pigs get heavier (Brumm, 1996).

Solid floors should be sloped (e.g., 2%) to allow water and manure to flow to a drain or a pit. Slotted floors need not be sloped. Although many flooring materials are acceptable, concrete slats are recommended for slotted floors. Concrete slats should be 9 to 20 cm (3.5 to 8 in) wide with an approximately 2.5-cm (1-in) slot between adjacent slats. Edges of slats should be rounded to preclude foot-claw injuries, and sharp edges should be avoided. Partially slotted floors are acceptable. Open flush gutter systems are acceptable, but risk of contamination between pens is greater.

Restricting the number of times pigs are moved or mixed is desirable because mixing pigs generally results in aggression, increases health problems, and causes performance setbacks.

Breeding and Gestation Systems

Sows, if managed properly, may be housed individually or in groups. When sows are kept in groups, social interactions are facilitated. When the group is fed a limited daily ration, competition for feed is often intense. Without intervention from animal care personnel, aggressive sows overeat, and subordinates ingest inadequate amounts of feed. Aggressive behavior in swine is common, and, if swine are left unattended, serious injury often results.

Stall housing for sows allows the caretaker to control individual feed allowances precisely but restricts sow movement. An alternative is a group pen equipped with individual stalls used only at feeding time.

Efforts to define the well-being of sows in different gestation housing systems have led to contrasting results and

TABLE 10-2. Minimum Floor Area Recommendations for the Animal Zone for Swine Used in Agricultural Research and Teaching.

Stage of production	Individual pigs (per pig)		Groups of pigs (per pig)[a]	
	(m^2)	(ft^2)	(m^2)	(ft^2)
Litter and lactating sow, pen	3.15	(35)	. . .	. . .
Litter and lactating sow, sow portion of crate	1.26	(14)	. . .	. . .
Nursery, 3 to 27 kg (7 to 60 lb) of body weight	.54	(6)	.16–.37	(1.7–4.0)
Growing, 27 to 57 kg (60 to125 lb) of body weight	.90	(10)	.37–.56	(4.0–6.0)
Finishing, 57 to 104 kg (125 to 230 lb) of body weight	1.26	(14)	.56–.74	(6.0–8.0)
Late finishing, 105 to 125 kg (231 to 275 lb) of body weight	1.26	(14)	.74–.84	(8.0–9.0)
Mature adults[b]	1.26	(14)	1.49	(16.0)

[a]Group area allowances for growing pigs range from starting to ending body weight in each phase. The needed floor area per pig decreases as group size increases (McGlone and Newby, 1994). The data presented here are for typical group sizes from 5 to 20 pigs per pen. For small group sizes (2 to 4 pigs), the pens should be longer than the body length of the largest pig in the pen.

[b]Stall size minimum width should be 56 cm (22 in), and minimum length should be 2.2 m (7 ft). Young adult females may be housed in stalls of 2 m (6.5 ft) length.

inconclusive interpretations (Brouns and Edwards, 1992). At present there is no consensus among scientists in identifying those factors responsible for the lack of agreement among studies. It has been suggested that specific genetic strains of sows may differ in their ability to adapt to particular housing environments (Beilharz, 1982), but this hypothesis has not been fully investigated. Inputs from managers, proper habituation, and selection of appropriate genetic stock appear to be primary contributors to the well-being of sows, independent of most gestation systems used.

Keeping gestating gilts and sows in tethers is banned for new facilities in the European Community member countries as of 1997. The net scientific opinion among some scientists is that, even under controlled conditions, the tether system can be stressful to the gilt or sow (Janssens, 1994, 1995; McGlone et al., 1994). Housing gifts and sows in tethers increases the attention required by management to ensure their proper application. Recent summaries of reproductive data in the field identified an association between use of tethers, lower farrowing rates, and more nonproductive sow days (PIC USA, Inc., 1994). Because both field and controlled studies point to the likelihood of reduced reproductive success and endocrine signs of a chronic stress response to tethers, the tether system is not recommended for teaching and research facilities.

Both field and controlled studies (McGlone et al., 1994; PIC USA, Inc., 1994; McGlone, 1995) support the idea that the individual crate or stall promotes high reproductive success and does not induce a stress response, based on endocrine and immune data. However, extended periods in crates may lead to muscle or bone weakness (Marchant and Broom, 1996). A properly designed crate or group system is an acceptable model production system for teaching and research units. Newer systems, presently under development, require extensive evaluation (Baxter, 1995) before being introduced as standard housing systems.

Housing. Recommended areas for breeding sows and boars of different types and sizes are listed in Table 10-2. Sexual development of gilts that have been selected to enter the breeding herd is hastened when they are kept in groups (10 to 12 per pen recommended in intensive production systems) with the opportunity for contact with mature boars for at least 30 min/day.

Sows in group pens (e.g., 5 to 10 per pen) and on restricted feed rations should be of uniform size and temperament. In extensive production systems, larger group sizes can be managed because feeding space per sow can be increased to reduce competition for feed.

Recommended dimensions for gestation stalls are .56 × 1.98 m and 1.02 m high (1.8 × 6.5 ft and 3.3 ft high) for gilts and .61 × 2.13 m and 1.02 m high (2 × 7 ft and 3.3 ft high) for sows. Standing sows and gilts should not be forcibly in contact with the sides, ends, or top of the stall (Curtis et al., 1989).

Individual housing of mature boars is recommended to preclude interactions among boars. When mature boars that are unfamiliar with one another are penned together, intense fighting usually occurs. In systems in which boars reside in small groups, boars should be of similar size, and it is highly desirable that they be reared together from the time of puberty.

Recommended dimensions of stalls for boars are .71 × 2.13 m and 1.17 m high (2.3 × 7 ft and 3.8 ft), but even larger stalls or pens may be required for extremely large boars.

Mating Facilities. Specialized facilities or areas are needed for breeding. Breeding may be by natural service or artificial insemination. Boar breeding areas should be slip-resistant. Artificial insemination areas include boar semen collection and sow insemination areas. Boar semen collection areas should be designed to consider boar and worker safety as well as animal comfort and sanitation. Sow insemination areas may be the same as gestation facilities for sows.

Pen mating (placing a boar with sows unattended) and hand mating (personnel attending boar-sow matings) are mating options. With pen mating in pasture and drylot systems, primary considerations are to minimize extremes in environmental temperature, rest boars between mating sessions, and avoid putting young boars with old sows or old boars with gilts.

For pen mating in intensive production systems, area allowance and flooring are additional considerations. Pens should be at least 2.44 m (8 ft) wide and provide at least 1.86 m^2 (20 ft^2) per sow or 1.6 m^2 (17 ft^2) per gilt. One boar per pen is recommended. Slip-resistant, dry floors are required to prevent injury.

With hand mating, the sow usually is mated in a designated mating pen but may be mated in the pen of either the sow or the boar. In any case, that pen should be a minimum of 2.44 × 2.44 m (8 × 8 ft) and have a slip-resistant floor.

The flooring surface in mating pens should be considered during the planning and construction of the facility. In pens with an area of solid concrete, floors may be made slip-resistant by applying a wood float or broom finish or by placing grooves in the concrete. A 2.5-cm (1-in) diamond pattern has proved satisfactory (Levis et al., 1985). In pens used for hand mating but without good footing, absorbent substances or rubber mats may be placed on the floor.

Sows kept for several parities may require special attention. Animal caretakers should be aware of the possibility of shoulder sores, long hoof growth, and thin body condition. These and other health problems should be treated as soon as they are identified.

Metabolism Stalls. Metabolism stalls are used to pen individual pigs for certain investigations of nutrition and physiology, with the approval of the ACUC. The metabolism stall usually keeps pigs in a manner that precludes them from turning around and soiling feed or eating feces. If the flooring and penning materials are appropriate for the size of the pig to be used and if the space allowances for individual pigs are met (Table 10-2), then pigs may be penned for extended periods in metabolism stalls without problems.

The precise width of a metabolism stall may require adjustments to provide total urine and fecal collection while preventing the pigs from turning or flipping. Slightly smaller space allowances may therefore be needed to accomplish these objectives. In studies requiring the use of metabolism stalls, twice daily interaction between the animal care staff and the pigs is especially important. Visual and vocal interactions with other pigs also support the well-being of individually housed pigs. Pigs should be held in metabolism stalls no longer than required by the approved animal care protocol.

STANDARD AGRICULTURAL PRACTICES

Castration

Boar taint, defined as a specific objectionable odor and flavor in meat, often occurs when boars are slaughtered at 100 kg (220 lb) of body weight or heavier. In view of demand by United States packers for heavier market hogs, almost all male pigs are castrated before slaughter. If teaching and research pigs are to be marketed in commercial chains, castration is recommended. If the research intends to reflect commercial pork production, castrated males are appropriate model animals.

Castration causes clear signs of pain and discomfort for pigs castrated at any age evaluated (McGlone and Hellman, 1988; McGlone et al., 1993; White et al., 1995). Signs of pain and discomfort include reduced times spent nursing or feeding, increased vocalization (apart from that induced by handling) as pigs increase in age, inflammation and swelling at the castration site, and acute reduction in performance.

To minimize stress on the pig, castration should be performed as early as possible and preferably between 1 and 14 days of age. After day 14 of age, local or general anesthetic should be administered prior to castration under prescription from the attending veterinarian. For boars of any age, trained personnel should use disinfected instruments, and a precastration disinfectant should be applied to the incision site. To allow proper drainage, the incision should be in the ventral scrotum and should not be sutured.

Other Standard Practices

Several other standard agricultural practices that cause only brief pain or distress but that prevent more serious distress or injury later in the pig's life may also be performed. Thus, teeth of pigs may be clipped at a very young age to reduce damage to littermates and to the sow. No more than one half of the tooth should be trimmed. Ears may be notched to provide permanent individual identification. Tails may be docked to reduce the potential for tail-biting. Tusks of boars may be trimmed to prevent them from harming humans or other pigs. Sows and boars may have their hooves trimmed to allow them to walk with greater ease and to avoid injuries.

HANDLING AND TRANSPORTATION

Guidelines for the handling and transportation of pigs are adapted from the *Swine Care Handbook* of the NPPC (1996). Safety and comfort should be of primary concern when transporting pigs. Weak pigs should not be loaded or transported with healthy ones. Appropriate steps should be taken to segregate sick and injured pigs immediately and to care for their special needs.

When pigs are transported, ventilation should be adequate, and the floor should be slip-resistant. When possible, animals should be shipped in groups of uniform weight. Pigs of 22.7 kg (50 lb) should have a minimum of .14 m^2 (1.5 ft^2), and 182-kg (400-lb) pigs should have .55 m^2 (6 ft^2) (Grandin, 1988, 1989).

Injuries and bruises can result in animal suffering and carcass damage when pigs are improperly managed during handling and transport. Recommendations for facility design for loading and unloading trucks, restraining animals, and handling them in packing plants have been published (Grandin, 1983, 1988, 1991).

Transport and handling stresses can be aggravated by adverse weather and wide temperature fluctuations. Hot weather is a time for particular caution. The Livestock Weather Safety Index (Grandin, 1992) is used as the basis for deciding how to handle and ship swine. Swine should not be transported during extreme weather. During transit in warm weather, swine should be protected from heat stress by being shaded, wetted, and bedded with wet sand or shavings. Prompt unloading in hot weather is essential because heat builds up rapidly in a stationary vehicle.

During transportation in cold weather, pigs should be protected from cold stress. Wind protection should be provided when the air temperature drops below 32°F (0°C), but ventilation must always be adequate. When trucks are in transit in cold weather for more than a few minutes, pigs should be bedded with chopped straw or other material that has high insulating properties. Water and feed should be readily available for trips longer than 24 hr. The ACUC should consider water needs during transport in hot weather.

Truck beds should ordinarily be clean and dry and equipped with a well-bedded, nonslip floor. Pigs should be loaded and unloaded promptly. The chutes used should be designed specifically for swine (Grandin, 1988). Injuries can be reduced when the pigs on a truck are held in several small groups and are handled and moved carefully.

Caretakers should seek to prevent animals from becoming nonambulatory by feeding nutritionally sound diets, maintaining sound health programs, providing good flooring surfaces, and selecting genetically sound breeding stock. Swine that are unable to walk or that are ill or severely injured and will not likely recover should be humanely

euthanatized at the facility and not be transported through market channels.

EUTHANASIA

The AVMA Panel on Euthanasia (AVMA, 1993) lists several methods of euthanasia that may be appropriate for pigs. Certain euthanasia techniques are suggested here for very young and adult pigs in consideration of both worker safety and humane euthanasia.

Carbon dioxide is a suitable method for euthanatizing swine providing that residual oxygen is removed quickly from the CO_2 chamber. This method requires a special chamber to administer the gas, which might be found in a biomedical facility. Carbon monoxide is not recommended because it is a potential human health hazard.

An overdose of anesthetic or injection with a euthanasia solution is a humane method that may be practiced after careful training in a teaching or research unit. Barbiturates require special handling and licensing.

As recommended by the AVMA (1993), larger swine (over 23 kg) may be euthanatized by lethal injection or penetrating captive bolt and exsanguination. Other recommended methods may be used if proper equipment and expertise are available.

SPECIAL CONSIDERATIONS

Pigs with Small Mature Body Size

Some specific strains of *Sus scrofa* or *Sus vittatus* have or have been selected to have a small mature body size. These strains include, but are not limited to mini, micro, and potbellied pigs. These pigs may be used in commercial agricultural production, but are more often kept as pets or used as biomedical research models. However, the husbandry requirements of these pigs are generally similar to those of traditional domestic pigs, with some exceptions.

Thermal and nutrient requirements should be carefully considered. Pigs with small mature body size are more sensitive to cool temperatures than are larger pigs because of their sparse hair coat and small body size. Because they are smaller and eat less per day, their nutrient requirements per weight of feed may be higher, although they must be limit-fed to control body condition (avert obesity). The physical plant (e.g., flooring and penning materials) should be appropriate for their body size.

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