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The welfare of animals during transport
(details for horses, pigs, sheep and cattle)

Report of the
Scientific Committee on Animal Health and Animal Welfare
Adopted on 11 March 2002

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1. MANDATE

The Scientific Committee on Animal Health and Animal Welfare has been asked to report on the welfare of animals during transport with consideration of Directives 91/628/EEC and 95/29/EC and Regulation EC/411/98. In particular, the effects on the welfare of the various species transported of: loading densities, travelling times, resting times, watering and feeding intervals and interactions of each of these with the use of upgraded or other vehicles and with any stress during loading and unloading. Other specific questions concern: the welfare of animals on roll-on roll-off vessels especially during boarding, the welfare of horses during long distance transport and the methods which operators and inspectors can use to monitor the welfare of animals during transport.

The Committee established an expert working group under the Chairmanship of Professor D.M. Broom. The members of this working group and of the Committee are listed at the end of this Report.

A previous report on this subject, entitled “The Transport of Farm Animals” was produced by the E.U. Scientific Veterinary Committee, Animal Welfare Section on 18th May 1992.

More recent relevant reports by the S.C.A.H.A.W. whose contents are not repeated here are : “Standards for the Microclimate inside Animal Transport Road Vehicles” 8th December 1999, “Strategy for Emergency Vaccination against Foot and Mouth Disease (FMD)” 10th March 1999, “Brucellosis in Sheep and Goats (*Brucella melitensis*)” 12th July 2001.

2. THE ASSESSMENT OF ANIMAL WELFARE DURING TRANSPORT AND ASSOCIATED HANDLING

2.1. Concepts

The status of animals has been the object of philosophical concern for a very long time (see review by Ouedraogo and Le Neindre, 1999). In particular, there is concern in many countries about the effects of transport and associated handling on the welfare of animals. Animals are now defined as “sentient creatures” in European law and no longer just as agricultural products (Treaty of Amsterdam, 1997). That change reflects ethical public concern about the quality of life of the animals. Farm animals are subject to human imposed constraints and for a very long time the choice of techniques has been based primarily on the efficiency of production. However it is an increasingly held view that we should protect those animals against mistreatment, or better still, to allow them the maximum of good welfare.

In order to safeguard welfare and avoid suffering, a wide range of needs must be fulfilled. These needs may require the animal to obtain resources, receive stimuli or express particular behaviours (Vestergaard 1996, Jensen and Toates 1993). To be useful in a scientific context, the concept of welfare has to be

defined in such a way that it can be scientifically assessed. This also facilitates its use in legislation and in discussions amongst farmers and consumers.

Welfare is clearly a characteristic of an individual animal and is concerned with the effects of all aspects of its genotype and environment on the individual (Duncan 1981). Broom (1986) defines it as follows: the welfare of an animal is its state as regards its attempts to cope with its environment. Welfare therefore includes the extent of failure to cope, which may lead to disease and injury, but also ease of coping or difficulty of coping. An important part of this state is that which involves attempts to cope with pathology, i.e. the health of the animal, so health is part of welfare. Furthermore, welfare includes pleasurable mental states and unpleasant states such as fear and frustration. Feelings are a part of many mechanisms for attempting to cope with good and bad aspects of life and most feelings must have evolved because of their beneficial effects (Broom 1998). Good welfare can occur provided the individual is able to adapt to or cope with the constraints to which it is exposed. Hence, welfare varies from very poor to very good and can be scientifically assessed. The word stress is used by some authors when there is failure to cope (Fraser and Broom 1990), but others use it for any situation in which an organism is forced to respond to environmental challenge (Selye 1980, Zulkifli and Siegel 1995).

The various mechanisms which exist within most animals for trying to cope with their environment and the different consequences of failure to cope mean that there are many possible measures of welfare. However, any one measure can show that welfare is poor. Measures which are relevant to animal welfare during handling and transport are described by Broom and Johnson (1993) and by Broom (2000).

2.2. Behaviour measures

The most obvious indicators that an animal is having difficulty coping with handling or transport are changes in behaviour which show that some aspect of the situation is aversive. The animal may stop moving forward, freeze, back off, run away, vocalize or show other behaviours including lying down. The occurrence of each of these can be quantified in comparisons of responses to different races, loading ramps, etc. Examples of behavioural responses such as cattle stopping when they encounter dark areas or sharp shadows in a race and pigs freezing when hit or subjected to other disturbing situations may be found in Grandin (1980, 1982, 1989).

The extent of behavioural responses to painful or otherwise unpleasant situations varies from one species to another according to the selection pressures which have operated during the evolution of the mechanisms controlling behaviour. Human approach and contact may elicit antipredator behaviour in farm animals, according to the animals' experience of interactions with humans (Hemsworth and Coleman 1998). Social species which can collaborate in defence against predators, such as pigs or man, vocalize a lot when caught or hurt. Species which are unlikely to be able to defend themselves, such as sheep, vocalize far less when caught by a predator, probably because such an extreme response merely would give

information to the predator that the animal attacked is severely injured and hence unlikely to be able to escape. Cattle can also be relatively undemonstrative when hurt or severely disturbed. The action of natural selection has resulted in pigs which squeal when injured and sheep which may show no behavioural response to a similar degree of injury (Broom and Johnson 1993). Human observers sometimes wrongly assume that an animal which is not vocalising is not injured or disturbed by what is being done to it. In some cases, the animal is showing a freezing response and in most cases, physiological measures must be used to find out the overall response of the animal. During the loading and unloading of animals into and out of transport vehicles, Broom *et al.*, (1996) and Parrott *et al.*, (1998a) showed that sheep exhibit largely physiological responses rather than behavioural and these are associated with the novel situation encountered in the vehicle rather than loading procedure. Pigs, on the other hand, are much affected by being driven up a ramp into a vehicle, the effect being greatest if the ramp is steep.

Individual animals may vary in their responses to potential stressors. The *coping strategy* adopted by the animal can have an effect on responses to the transport and lairage situation. For example, Geverink *et al.*, (1998) showed that those pigs that were most aggressive in their home pen were also more likely to fight during pre-transport or pre-slaughter handling but pigs which were driven for some distance prior to transport were less likely to fight and, as a consequence, cause skin damage during and after transport. This fact can be used to design a test which reveals whether or not the animals are likely to be severely affected by the transport situation (Lambooj *et al.*, 1995).

When hens are to be removed from a cage they move away from an approaching human. Broiler chickens or turkeys, which are much less mobile than hens, may not always move away from a person who is trying to catch them but, given time, their behaviour indicates that they are *disturbed by close human approach*. After poultry are picked up by humans they may struggle but often hang limply and if put down, show a freezing response (Broom 2000). The behavioural response to being caught and carried is generally one of passive fear behaviour and is frequently not recognised by the people handling them as indicating the severe disturbance which is revealed by physiological measures.

Once journeys start, some species of farm animals explore the compartment in which they are placed and try to find a suitable place to sit or lie down. Unfortunately for the animals, many journeys involve so many lateral movements or sudden brakings or accelerations, that the animals cannot lie down. The number of pigs, or other animals, which remain standing during transport is a relevant measure of welfare in relation to the roughness of the journey. For example, Bradshaw *et al.*, (1996a) found that more pigs remain standing during a rough journey, measured in terms of accelerations in three possible planes, than during a smooth journey. In journeys with certain vibration characteristics, pigs show behavioural evidence of motion sickness in that they retch and vomit (Bradshaw *et al.*, 1996b, Randall and Bradshaw 1998).

An important behavioural measure of welfare when animals are transported is the amount of *fighting* that they show. This fighting is a consequence of social

mixing rather than the transport itself. When adult male cattle are mixed during transport or in lairage, they may fight and this behaviour can be recorded directly (Kenny and Tarrant 1987). Calves of 6 months of age may also fight (Trunkfield and Broom 1990) and fighting can be a serious problem in pigs (Guise and Penny 1989, Bradshaw *et al.*, 1996c). The recording of such behaviour should include the occurrence of threats as well as the contact behaviours which might cause injury, for example those described by Jensen (1994) for pigs.

A further, valuable, method of using behaviour studies to assess the welfare of farm animals during handling and transport involves using the fact that the animals *remember aversive situations* in experimentally repeated exposures to such situations. Any stock-keeper will be familiar with the animal which refuses to go into a crush after having received painful treatment in it in the past or hesitates about passing a place where a frightening event such as a dog threat occurred before. These observations give us information about the welfare of the animal in the past as well as at the present time. If the animal tries not to return to a place where it had an experience then that experience was clearly aversive. The greater the reluctance of the animal to return, the greater the previous aversion must have been. This principle has been used by Rushen (1986a,b) in studies with sheep.

2.3. Physiological and biochemical measures

The physiological responses of animals to adverse conditions, such as those which they may encounter during handling and transport, will be affected by the *anatomical and physiological constitution* of the animal. Whenever physiological measurement is to be interpreted it is important to ascertain the *basal level* for that measure and how it fluctuates over time. For example, plasma cortisol levels in most species vary during the day and tend to be higher during the morning than during the afternoon. Physiological measures are summarised in Table 1.

Table 1 Commonly used physiological indicators of stress during transport

Stressor	Physiological variable
Measured in blood or other body fluids	
Food deprivation	↑ FFA, ↑ β-OHB, ↓ glucose, ↑ urea
Dehydration	↑ Osmolality, ↑ total protein, ↑albumin, ↑ PCV
Physical exertion	↑ CK, ↑ lactate
Fear/arousal	↑ Cortisol, ↑ PCV
Motion sickness	↑ Vasopressin
Other measures	
Fear/arousal and physical	↑ Heart rate, heart rate variability ↑, ↑ respiration rate
Hypothermia/hyperthermia	Body temperature, skin temperature

FFA, free fatty acids; β-OHB, β-hydroxybutyrate; PCV, packed-cell volume; CK, creatine kinase. (modified after Knowles and Warriss 2000).

Heart rate can decrease when animals are frightened but in most farm animal studies, tachycardia an increase in heart rate has been found to be associated with disturbing situations. Van Putten and Elshof (1978) found that the heart rate of pigs increased by a factor of 1.5 when an electric goad was used on them and by 1.65 when they were made to climb a ramp. Steeper ramps caused greater increases up to a maximum level (van Putten, 1982). Heart rate increase is not just a consequence of increased activity; it can be increased in preparation for an expected future flight response. Baldock and Sibly (1990) obtained basal levels for heart rate during a variety of activities by sheep and then took account of these when calculating responses to various treatments. Heart rate is a useful measure of welfare but only for short-term stressors such as those encountered by animals during handling, loading on to vehicles and certain acute effects during the transport itself. However, some adverse conditions may lead to elevated heart rate for quite long periods Parrott *et al.*,

(1998a) showed that heart rate increased from about 100 to about 160 beats per minute when sheep were loaded on to a vehicle and the period of elevation of heart rate was at least 15 minutes. During transport of sheep, heart rate remained elevated for at least nine hours (Parrott *et al.*, 1998b). Heart rate variability is also a valuable measure of the welfare of animals, those individuals with greater variability being the most disturbed (van Ravenswaaij *et al.* 1993, Minero *et al.* 2002).

Direct observation of animals without any attachment of recording instruments or sampling of body fluids can provide information about physiological processes (Broom 1995). *Breathing rate* can be observed directly or from good quality video recordings. The metabolic rate and level of muscular activity are major determinants of breathing rate but an animal which is disturbed by events in its environment may suddenly start to breathe fast. *Muscle tremor* can be directly observed and is sometimes associated with fear. *Foaming at the mouth* can have a variety of causes, so care is needed in interpreting the observations, but its occurrence may provide some information about welfare.

Changes in the *adrenal medullary hormones* adrenaline and noradrenaline occur very rapidly and measurements of these hormones have been little used in assessing welfare during transport. However, Parrott *et al.*, (1998a) found that both hormones increased more during loading of sheep by means of a ramp than by loading with a lift. *Adrenal cortex* responses occur in most of the situations which lead to aversion behaviour or heart rate increase but the effects take a few minutes to be evident and they last for 15 min. to 2 h. or a little longer. Plasma corticosterone levels in hens at depopulation were three times as high after normal, rough handling than after gentle handling (Broom *et al.*, 1986, Broom and Knowles 1989) and those of broilers were three and a half times the resting level after 2 h of transport and four and a quarter times higher after 4 h of transport (Freeman *et al.*, 1984, and review by Knowles and Broom, 1990). The cortisol response to handling and transport depends upon the species and on the breed of animal studied (Hall *et al.*, 1998a). When sheep were loaded on to a vehicle for the first time, all showed elevated plasma and saliva cortisol for at least the first hour (Broom *et al.*, 1996, Parrott *et al.*, 1998b). Cortisol levels in transported pigs were affected by being on a rough rather than a smooth journey (Bradshaw *et al.*, 1996b), being mixed with pigs from different origin and being on a moving vehicle rather than being stationary (Bradshaw *et al.*, 1996c).

Animals that have substantial adrenal cortex responses during handling and transport show increased body temperature (Trunkfield *et al.*, 1991, Parrott *et al.*, 1999). The increase is usually of the order of 1 C but the actual value at the end of a journey will depend upon the extent to which any adaptation of the initial response has occurred.

In humans, *vasopressin* increases in the blood when the individual reports a feeling of nausea associated with motion sickness. Pigs also show motion sickness, retching and ejection of gut contents, especially when travelling along windy roads. These physical signs of motion sickness occur at the same time as increases in the levels of lysine vasopressin in the blood. Bradshaw *et*

al., (1996b) showed that increased vomiting and retching in pigs coincided with higher levels of lysine vasopressin.

The measurement of *oxytocin* has not been of particular value in animal transport studies (e.g. Hall *et al.*, 1998). However, plasma β -*endorphin* levels increase during the loading of pigs (Bradshaw *et al.*, 1996b). Measurement of beta-endorphin levels in blood is useful to complement ACTH or cortisol measurement.

Creatine kinase is released into the blood when there is muscle damage e.g. bruising, and when there is vigorous exercise. It is clear that some kinds of damage which affect welfare result in creatine kinase release so it can be used in conjunction with other indicators as a welfare measure. *Lactate dehydrogenase* (LDH) also increases in the blood after muscle tissue damage but increases can occur in animals whose muscles are not overtly bruised or cut. Deer which are very frightened by capture show large LDH increases (Jones and Price 1992). The isomer of LDH which occurs in striated muscle (LDH5) leaks into the blood when animals are very disturbed so the ratio of LDH5 to total LDH is of particular interest.

When animals are transported they will be deprived of water to some extent. The most obvious and straightforward way to assess this is to measure the *osmolality* of the blood (Broom *et al.*, 1996). When food reserves are used up there are various changes evident in the metabolites present in the blood. Several of these, for example *beta -hydroxy butyrate*, can be measured and in some species indicate the extent to which the food reserve depletion is serious for the animal. Another measure which gives information about the significance for the animal of food deprivation is the delay since the last meal. Most farm animals are accustomed to feeding at regular times and if feeding is prevented, especially when high rates of metabolism occur during journeys, the animals will be disturbed. Behavioural responses when allowed to eat or drink (e.g. Hall *et al.*, 1997) also give important information about problems of deprivation.

The *haematocrit*, the proportion of red blood cells in the blood, is altered when animals are transported. If animals encounter a problem, such as those which may occur when they are handled or transported, there can be a release of blood cells from the spleen and a higher cell count (Parrott *et al.*, 1998b). More prolonged problems, however, are likely to result in reduced cell counts (Broom *et al.*, 1996).

A change which can be mediated by increased adrenal cortex activity and which may provide information about the welfare of animals during transport is *immunosuppression*. One or two studies in which animal transport affected T-cell function are reviewed by Kelley (1985) but such measurements are likely to be of more use in the assessment of longer-term welfare problems.

In the course of a journey, pathological conditions may arise or become exacerbated. The extent of such effects can be assessed by clinical examination as well as by other measures of welfare.

2.4. Mortality, Injury and Carcass Characteristics

The term welfare is relevant only when an animal is alive but death during handling and transport is usually preceded by a period of poor welfare. *Mortality records* during journeys are often the only record which give information about welfare during the journey and the severity of the problems for the animals are often only too clear from such records. The number of pigs which were dead on arrival at the slaughterhouse was 0.07% in the UK and The Netherlands in the early 1990s although the situation was worse in the past, especially with the Pietrain and Landrace breeds. The level in the Netherlands in 1970 was 0.7%. Recent estimates of the numbers of broilers and laying hens dead on arrival at UK slaughterhouses are 0.4% and 0.5% respectively but mortality of laying hens has been reported to be up to fifty times higher on occasion (Knowles and Broom, 1990b).

Amongst extreme injuries during transport are *broken bones*. These are rare in cattle, sheep, pigs or horses but poor loading or unloading facilities and cruel or poorly trained staff who are attempting to move the animals may cause severe injuries. It is the laying hen, however, which is most likely to have bones broken during transit from housing conditions to point of slaughter, (Gregory and Wilkins 1989), especially if the birds have had insufficient exercise in a battery cage, (Knowles and Broom 1990a).

Measurements made after slaughter can provide information about the welfare of the animals during handling, transport and lairage. *Bruising*, lacerations and other superficial *blemishes* can be scored in a precise way and when carcasses are down-graded for these reasons, the people in charge of the animals can reasonably be criticised for not making sufficient efforts to prevent poor welfare (Guise and Penny 1989). The cost, in both senses, of dark firm dry (DFD) and pale soft exudative (PSE) meat is even greater than this. DFD meat is associated with fighting in cattle and pigs but cattle which are threatened but not directly involved in fights also show it (Tarrant, personal communication). PSE meat is in part a consequence of possession of certain genes and occurs more in some strains of pigs than others but its occurrence is related in most cases to other indicators of poor welfare (Tarrant 1989).

2.5. Experimental methods

As Hall and Bradshaw (1998) explain, information on the stress effects of transport is available from five kinds of study:

1. Studies where transport, not necessarily in conditions representative of commercial practice, was used explicitly as a stressor to evoke a physiological response of particular interest (Smart *et al.*, 1994, Horton *et al.*, 1996).
2. Uncontrolled studies with physiological and behavioural measurements being made before and after long or short commercial or experimental journeys (Becker *et al.*, 1985, Dalin *et al.*, 1988, Becker *et al.*, 1989, Dalin *et al.*, 1993, Knowles *et al.*, 1994a).

3. Uncontrolled studies during long or short commercial or experimental journeys (Lambooy 1988, Hall 1995).
4. Studies comparing animals that were transported with animals that were left behind to act as controls (Nyberg *et al.*, 1988, Knowles *et al.*, 1995).
5. Studies where the different stressors that impinge on an animal during transport were separated out either by experimental design (Bradshaw *et al.*, 1996c, Broom *et al.*, 1996, Cockram *et al.*, 1996) or by statistical analysis (Hall *et al.*, 1998c).

Each of these methods is of value because some are carefully controlled but less representative of commercial conditions whilst others show what happens during commercial journeys but are less well controlled.

2.6. Conclusions

The welfare of animals during handling and transport can be assessed using a range of measures of behavioural, physiological, biochemical, pathological and carcass condition changes. Incidences of injury, morbidity and mortality at the end of transport can also be measured and the magnitude of effects on previous welfare deduced.

3. EFFECTS OF TRANSPORT ON LATER WELFARE, IN PARTICULAR DISEASE

3.1. Welfare and disease

Poor welfare during transport may have prolonged effects on the welfare of the transported animals. The stressful effects of the transport may themselves continue or they may put the transported individual at greater risk of disease. Health is an important part of welfare and any increase in disease means poorer welfare. Indicators of poor welfare, whilst not being signs of poor health at that time, may indicate a risk of poor health in the future. In addition, however, the transmission of some pathogens is more likely because of various aspects of animal transport procedures. Animals within a vehicle may become diseased and disease may occur in non-transported individuals because of the spread of pathogens from transported animals. Each of these topics is considered briefly here, commencing with mention of some of the processes involved.

3.2. Processes involved in transport effects on disease

3.2.1. Introduction

In relation to transport, disease can result from tissue damage and malfunction in transported animals, pathogens already present in transported animals, pathogens transmitted from one transported animal to another, or pathogens transported from transported animals to other animals directly or indirectly, e.g. via equipment. Transport and associated handling can affect the susceptibility of individuals to pathogens, the infectiousness of individuals carrying pathogens or the extent of contact which might result in transmission of pathogens. A further factor affecting disease transmission is the extent of

resistance of the pathogen to environmental challenges. Where disease levels are increased because of transport there are differences between infections which are largely monocausal, such as foot and mouth disease (FMD), where the immune status of the animal is less important, and diseases with multifactorial causation where immune state is a major factor.

3.2.2. *Enhanced susceptibility for infection and disease*

A variety of stressors are associated with transport and it is to be expected that transport-related stress situations enhance the susceptibility for infection by lowering the infection threshold, or the amount of pathogen needed to initiate an infection in an animal. However, transmission of pathogens does not always mean that disease is induced in the recipient animal. The susceptibility of individuals for disease is affected by the efficacy of body defence systems, especially the immune system. Poor welfare can make these systems less efficient and certain behavioural pathologies or redirected behaviours can result in serious injury or predisposition to infection, either in the animal itself or in others (Moberg and Mench 2000). The links between poor welfare and immunosuppression are reviewed by Broom and Johnson (1993). In all of these cases, poor welfare precedes poor health and is instrumental in its deterioration. One example of treatment which increases adrenal cortex activity and susceptibility to disease is mixing of chickens or pigs with strangers. Both administration of glucocorticoids and such mixing increases susceptibility to pathogen challenge with Newcastle disease and Marek's disease in chickens (Gross and Colmano 1969, 1971) and swine vesicular disease in pigs (Lin et al 1998). Mixing of pigs and consequent fighting can also depress anti-viral immunity in the long term (de Groot et al 2001).

Transport in general has been shown to increase: pneumonia and subsequent mortality caused by bovine herpes virus-1 in calves (Filion *et al.*, 1984), pneumonia caused by pasteurellosis (shipping fever) and mortality in calves and sheep (Radostits *et al.*, 2000, Brogden *et al.*, 1998), and salmonellosis in sheep (Higgs *et al.*, 1993) and horses (Owen *et al.*, 1983). A combination of different stressors often has a greater effect than a single stressor, as emphasised in much of this report. Transport itself involves such a combination but it may also be combined with other stressors. When young animals are weaned just before transport, the absence of maternal care and absence of milk is added to the various stressors associated with transport so disease condition is more likely in such animals. Also, one pathogen may affect susceptibility to others. Or for example, viral infections which may be sub-clinical increase the susceptibility for secondary bacterial infections and this may lead to severe disease (Brogden et al 1998).

3.2.3. *Enhanced infectiousness*

Transmission of a pathogenic agent begins with shedding from the infected host through oronasal fluids, respiratory aerosols, faeces, or other secretions or excretions. The routes of shedding vary with the infectious disease. For instance, rotavirus is mainly transmitted through faeces, and bovine herpesvirus 1 (BHV1) through the respiratory route. The amount and duration of virus shedding largely determine the infectiousness of an infected host.

When animals are transported they are subjected to a variety of stressors. Thus, transport may influence determinants of pathogen transmission. Animals that are in the incubation period of an infection or are subclinically infected can shed pathogens, without showing clinical signs of disease. It is possible that stress related to the transport can enhance the level and duration of pathogen shedding in subclinically infected animals and thereby enhance their infectiousness.

Transport can lead to reactivation of bovine herpes virus 1 (BHV1) for calves latently infected with a vaccine strain of BHV1 started to shed virus, at low titres, one day after having been transported (Thiry et al 1987).

3.2.4. *Enhanced contact*

It is clear that transport augments the intensity and frequency of contacts between animals. In particular, when animals from different herds, in which often different pathogens are endemic, are mixed, the chance of transmission of pathogens is relatively high.

Excreted pathogens must survive in the environment if they are to infect another host. When there is direct physical contact between animals, as is often the case in food animal husbandry, the environmental stability of the pathogen may hardly influence transmission. However, when animal contacts are less intense and the pathogen is transmitted by aerosolized droplets its environmental stability becomes more relevant in determining transmissibility. This is also the case when the pathogen is transmitted indirectly, for instance by contaminated clothing, equipment and vehicles etc. Not only intensity but also frequency of contacts between animals obviously and significantly influence the rate of pathogen transmission.

3.2.5. *Pathogen resistance to environmental factors*

The transport of animals will often result in contamination of collecting stations, markets, vehicles and other equipment, through the excretion of pathogens by the transported animals. This may result in indirect transmission.

The more resistant the virus is against environmental conditions, the greater the chance that the virus may be transmitted indirectly. Examples of such resistant viruses are porcine parvovirus and swine vesicular disease virus. For these viruses, it has been demonstrated experimentally, that pigs can become infected by being introduced into pens that were contaminated by infected pigs housed in these pens before (Mengeling and Paul 1986, Dekker et al 1995). However, less resistant viruses can also be transmitted in indirect ways. Examples of this are FMD and classical swine fever (CSF) viruses.

3.3. Direct effects of transport on the animals

In many reports of the effects of transport on disease incidence, information about neither the exact aspect of the transport process which affects the animals, nor the pathogen which is involved, is available. A term commonly

used for the disease condition is 'shipping fever'. This is a syndrome which develops a few hours or one or two days after transport. The pathogens which cause the condition are generally present in the host before the transport although some spread from one individual to another must sometimes occur. The pathogen is often, but not always, a commensal or is latent normally in the animals. The multiplication of one may affect the likelihood of growth of another, for example virus-induced cellular pathology in the respiratory tracts can form the ideal medium for the proliferation of formerly commensal bacteria. Many transport-induced diseases affect the respiratory system but some affect gastro-intestinal or other systems. Young animals are especially vulnerable.

Pathogens of especial importance in shipping fever are: for cattle *Pasteurella* species, bovine respiratory syncytial virus, infectious bovine rhinotracheitis, and para-influenza virus 3; for horses *Pasteurella* species and several herpes viruses; for sheep *Pasteurella* species and para-influenza virus 3. Pigs can also be affected. Some gastrointestinal diseases can also develop, usually a few days after transport and are associated with a variety of pathogens such as rotaviruses, *Escherichia coli* and *Salmonella* spp. Shipping stress may cause the reactivation of viruses which are present in the animals as a result of a previous infection (e.g. IBR, Aujeszky's disease virus, equine herpesvirus 1). Herpesviruses may, after stress, recrudescence from sites of latency such as nerve ganglia or leucocytes. The viruses may be harboured in the tonsils of animals, foot and mouth disease virus is an example of a virus which may proliferate and be shed from the tonsils in stressed animals. Pathogens such as rotaviruses or *E.coli*, may be harboured in the gut and then become pathogenic after stress. Serum protein and chemistry alterations appear in the blood of animals as a consequence of the transport stress. They may decrease the bactericidal activity of blood and immune response to vaccines. Immunised transported animals may become vulnerable to infection and live vaccine use may be inadvisable in newly transported animals.

3.4. Effects of transport on transmission and disease

Transported animals may become infected with pathogens which come from other individuals with which they are mixed or from an environment contaminated by other animals. Except where animals are to be slaughtered very soon after transport, such infections can be of considerable importance in relation to the welfare of the individuals and the costs of animal production. For example, in young animals which are mixed with individuals from other buildings or other farms and transported are much more likely to become infected with respiratory and gastrointestinal diseases. Disease may also be transmitted to non-transported animals as a result of transport.

If animals with foot and mouth disease (FMD) or classical swine fever (CSF) are transported, perhaps through a market or staging point, there is a major risk of spreading the disease. This was well documented in 2001 when FMD was transmitted within the United Kingdom and also from animals which came from the United Kingdom to calves at a staging point in France. During the outbreak of CSF in The Netherlands in 1997, the disease was spread by

transport vehicles on some occasions. Other important diseases which may be transmitted include bovine viral diarrhoea, African swine fever, swine dysentery, swine vesicular disease, porcine reproductive and respiratory syndrome, post weaning multi-system weaning syndrome, porcine dermatitis and nephropathy syndrome, enzootic pneumonia, bovine rhinotracheitis, rinderpest, glanders and sheep scab. Where poultry are transported, numerous diseases including highly pathogenic avian influenza (HPAI) and Newcastle disease could be transmitted.

Some of the diseases mentioned above are O.I.E. List A diseases and all are of considerable importance in their effect on the welfare of animals and the economics of farming. Bätza (2001) reviews the livestock diseases which might be brought into the European Union. In particular, the world distributions and risks of the following O.I.E. List A diseases: foot and mouth disease, African swine fever, classical swine fever, highly pathogenic avian influenza and Newcastle disease. Schlüter and Kramer (2001) summarise the outbreaks in the E.U. of foot and mouth disease and classical swine fever in farm livestock and rabies in wild foxes. In an analysis of the spread of classical swine fever, they concluded that, once the disease was in the farm animal population, at least 9% of further spread was caused by animal transport. The disease was transmitted a significant distance (estimate 22 km) if animals were taken to market and a much greater distance (estimate 110 km) if transport for further sale or for slaughter occurred.

If animals are checked by a veterinary surgeon before leaving on a journey which may last one or more days, they may develop a disease during the journey to a point where they can transmit it when they reach a market or staging point or their final destination. Hence whilst veterinary inspection can considerably reduce the spread of disease via transported animals, it cannot prevent it. If animals do not leave the transport vehicle, infection can still be spread via urine and faeces leaking from the vehicle and via human agency. Precautions can be taken to prevent uncontrolled fluid loss from vehicles and to minimise disease transmission via humans. If animals are unloaded into a market or at a staging point, there may be mixing of animals and contacts which transmit disease can readily occur. The contacts are likely to be considerably greater in a market than at a staging point.

3.5. Conclusions

Some pathogens which do not result in a disease condition in farm animals kept in good conditions, become activated during transport, often because of some degree of immunosuppression resulting from stress during transport. These pathogens, for example *Pasteurella* species and several rotaviruses and herpesviruses, proliferate and cause disease conditions in animals reared after transport. Transport may also cause reactivation and excretion of viruses in carrier animals and augment the severity of disease signs leading to higher mortality.

Transported animals may become infected with pathogens which come from other individuals. Disease may also be transmitted to non-transported animals because of transport. Important diseases which might be transmitted in this way include foot and mouth disease, classical swine fever, bovine viral

diarrhoea, swine vesicular disease, sheep scab, highly pathogenic avian influenza and Newcastle disease. The disease spread may occur over great distances because of transport. Transmission from infected transported animals is much more likely if other animals are brought into contact with them or their products at markets or at staging points than if there is no unloading from the vehicle.

4. INSPECTION

4.1. Inspection before and during transport

Animals may be inspected before, during and after transport. Animals which are to be transported could be unfit to travel because they are injured or diseased or could be fit to travel only in conditions which are better than those which are the minimal ones permitted by law. Decisions about fitness to travel are discussed in below and in the Federation of Veterinarians of Europe Position Paper “Transport of Live Animals” 2001. When animals transported for slaughter arrive at a slaughterhouse a pre-mortem inspection is required. Decisions about disease conditions at either of these times require veterinary expertise.

Road vehicles carrying livestock may also be inspected by border crossing inspectors, the police, or animal protection society inspectors in order to check vehicle design, conditions of animals, or other compliance with legislation. However, most inspections of transported animals are those carried out by the person responsible for the animals at the place of origin or during the journey.

The person responsible for animals at the point of origin and the driver of the vehicle or other person responsible for the animals during the journey should have the ability to evaluate animal welfare, at least to distinguish an animal which is dead, injured or obviously diseased. Some of the methods of assessing animal welfare described in Chapter 2 can be used, together with the range of observations mentioned in the Recommendations of the Committees of the Council of Europe Conventions on the Protection of Animals Kept for Farming Purposes and on Animals during Transport. A person driving a vehicle containing livestock will need to check the animals in the vehicle at regular intervals during a long journey and after any situation which might cause problems for the animals, such as a period of excessive vehicle movement, a period when overheating might have occurred, or a road accident. The intervals between regular checks correspond to the intervals between rest periods which are prescribed by law for drivers.

The checking of animals involves visual inspection and awareness of auditory and olfactory cues that the animals have problems. It is necessary that each individual can be seen so the design of vehicles, distribution of animals in the vehicle and stocking density must allow for this. If animals cannot be inspected, for example poultry which are put into stacked crates or sliding drawer units, on long journeys there are significant risks of poor welfare.

The veterinarian is the person ultimately responsible to declare an animal fit or unfit for travel. The Federation of Veterinarian of Europe’s Position Paper

on the Transport of Live Animals (FVE, 2001) provides useful information on those conditions that render an animal unfit for travel. Basically, pregnant animals in the last 10% of the gestation period, animals that have given birth during the preceding 48 hours and newborn animals in which the navel has not completely healed are considered unfit for travel in all cases. Animals that are unable to walk unaided onto the vehicle because of serious disease or injury are considered to be unfit for travel in nearly all cases. A list of conditions that render an animal unfit for travel, which provides useful information, is presented in Table 2 (FVE 2001). Apart from the conditions listed by the Federation of Veterinarians of Europe, there are cases in which an animal can not be considered unfit for travel but yet deserves special consideration during transport, particularly during loading and unloading. Old sows are an obvious example of this because they are prone to joint disorders which make it painful to walk or stand in a moving vehicle.

Table 2 Animals Unfit to Travel (modified after FVE 2001).

Always unfit:

1. Pregnant animals in the last 10% of the gestation period
2. Animals that have given birth during the preceding 48 hours
3. Newborn animals in which the navel has not completely healed, e.g. not dried/fallen off, calves <14 days old. This excludes horses, where a foal can be transported without harm if together with the mare in a separate compartment.

Unfit for normal transport but exceptional provisions could be made:

Animals, that are, because of serious disease or injury, unable to walk unaided onto the vehicle (without e.g. the usage of electric goads or dragging) or which can be expected not to be able to descend from the vehicle unaided such as:

1. Downers: alert cows which are unable to rise to a standing position but will eat and drink
2. Animals, that experience severe pain when moving e.g. animals with broken extremities or a broken pelvis
3. Animals with large, deep wounds
4. Animals with severe haemorrhages
5. Animals with severe system disorders
6. Animals that are only able to stand after being forced (e.g. very weak, fatigued or emaciated animals)
7. Animals, that are lame to such a degree that they can put little or no weight on one of their legs

8. Animals with a uterine prolapse
 9. Animals, that have just been dehorned
 10. Animals, with visible cardiovascular or respiratory disorders, e.g. pigs with red skin areas, forced inhalation, respiratory distress, gasping for air.
 11. Animals with severe inflammation, e.g. due to mastitis or pneumonia
 12. Animals, that lack coordination (e.g. animals that have difficulties keeping their balance, animals that have been given sedative drugs)
 13. Animals, that have an obviously disturbed reaction to their environment (e.g. extreme agitation, disorder of nervous system, intoxication)
 14. Animals with a substantial rectal prolapse
 15. Animals with torn off horns
 16. Blind animals
-

For cattle, sheep, pigs and horses, inspection facilities are needed for the person on the vehicle who is responsible for the animals. It is often possible to check each individual transported horse inside the vehicle without danger to the person inspecting or undue disturbance to the animals. However, other animals, such as adult cattle in groups, cannot be inspected from inside the vehicle without danger to the person inspecting. In this case, external inspection facilities which allow each individual to be seen are necessary. Inspection of sheep and pigs will normally be adequately done from outside provided that every individual can be seen. If inspection from inside the vehicle is required, the height of the deck must be sufficient for effective inspection.

If sick, injured or dead animals are found, the person responsible needs clear knowledge of, or instructions about, what to do. It is important that records are kept and made available to the competent authority, for example to veterinary inspectors, of all sick, injured or dead animals, including any disposed of during a journey. Where the animals are transported to slaughter, the abattoir as well as the owner of the animals will need a copy of the record. If an animal is found to be sick or injured on a journey, humane killing on the vehicle will sometimes be required. Hence, the responsible person on the vehicle will need to carry, and be trained in the use of, equipment for humane killing of the species carried. Where the injury or sickness is such that the animal cannot complete the journey, for example if it cannot stand unaided, the animal should be killed or unloaded as soon as possible at an appropriate place.

When animals die or are killed, the journey can continue for a time and to a place which is appropriate for the disposal of the carcass. In many cases of injury, sickness or death, it is important to inform the competent authority of the region. This is especially important if any important infectious disease is

suspected. Journey plans include the addresses, e-mail addresses and telephone numbers of the competent authorities in each of the regions passed through during the journey.

4.2. Conclusions

Animals may be unfit to travel because they are injured or diseased, or they may be fit to travel only in better conditions than the minimal ones permitted by law or for a short journey rather than a long journey. The person responsible for the animals at the point of origin or during the journey can inspect the animals in order to decide whether or not they are fit to travel. During journeys, poor vehicle design or distribution of animals, or too high a stocking density, can prevent effective and safe inspection of each animal.

Where checks involving recognition of disease conditions are required before the journey commences, or where the person responsible for the animals carries out an inspection and suspects that a disease condition which is of significance for the welfare of a particular animal or which is liable to be transmitted to other animals, inspection by a veterinarian is needed.

The timing of veterinary inspection is important. If it is not carried out immediately before transport there is an increased risk that animals will be unfit when transport commences or that a disease condition will develop during transport.

It may be necessary for animals to be humanely killed, using appropriate equipment, during a journey, or for animals to be unloaded at an appropriate place, or for a potentially important disease condition to be reported to the competent authority of the region.

The detection of unduly long journeys and the tracing of the sources of animals which are found to be diseased are facilitated by effective systems for the identification of each individual animal and the keeping of proper records of transport. Marking methods which involve mutilation of animals involve poor welfare.

5. TRAINING AND PAYMENT OF PERSONNEL

5.1. Training of personnel and payment to promote good welfare

One of the most important variables affecting the welfare of animals during transport is the behaviour of people who load and unload animals, or drive the vehicle (Lambooij et al 1999). Those who are moving the animals may cause much fear or pain deliberately or accidentally. Those who drive vehicles may also contribute directly to poor welfare in the animals by driving too fast around corners, or by violent braking or acceleration. They may also subject animals to extremes of temperature by leaving vehicles stationary in direct sunlight during hot weather or by exposing animals to wind and low temperatures during cold weather. These problems can be addressed by education, good management and a method of payment which promotes good welfare rather than speedy completion of the journey.

Education of those responsible for animals during transport is essential if poor welfare during transport is to be minimised. There are many who drive a road vehicle who do not know enough about animals to be able to care for a load of animals during a journey. As a consequence, training courses are needed by all who do such jobs. In some Member States such courses for livestock vehicle drivers are already provided. A legal requirement for a certificate issued after completion of an approved course is a valuable way of ensuring that persons with responsibility for large numbers of animals know how to prevent poor welfare in those animals. The driving standard for vehicles containing animals should be much better than those for human passengers who are supported in seats or standing with effective means of holding on and maintaining their balance. Most animal transport vehicle drivers are unaware of this so any requirement for training should also apply to those who already have experience in driving such vehicles. If the certification of drivers and others responsible for animals during transport can be withdrawn from those whose conduct warrants it, the improvement in the welfare of transported animals is likely to be greater.

A range of studies have shown that the method of payment of those who are responsible for animals during transport can have a considerable effect on animal welfare (Broom 2000). Guise (1991) found that if drivers received a bonus for reducing fuel consumption during animal transport, they drove more slowly, accelerated less and hence the animals were thrown about in the vehicles less, their welfare was better and the meat quality after slaughter was better. Similarly, Grandin (2000) reported that when drivers received a bonus if the meat quality after transport was above a certain standard, there was a dramatic improvement in animal welfare. Bonus payments or penalty deductions can be related to measurable quantities at the end of the journey to the slaughterhouse, in particular the number of animals dead on arrival, the number of animals found to have bruises or broken bones, and the number of animals with dark firm dry (DFD) or pale soft exudative (PSE) meat. In each case acceptable threshold levels need to be defined.

Where those who transport animals can insure against losses due to mortality, bruising, bone breakage, DFD meat or PSE meat, the incentive for drivers and others to treat animals well can be lost and welfare can be very poor. Therefore, such insurance should not be permitted. Normal insurance against road accidents poses no problem on animal welfare grounds.

5.2. Conclusions

Some people who load or unload animals, or drive vehicles, do not treat the animals as sentient beings whose welfare should be safeguarded, or as the source of valuable commodities whose quality and value can be reduced by poor treatment. Many livestock vehicle drivers are unaware that when vehicles go around corners or bends too quickly, or are caused to accelerate or brake rapidly, the animals are thrown about or seriously disturbed much more readily than human passengers who are sitting on a seat or standing but holding on to a fitment attached to the vehicle. Hence the welfare of animals is often very poor during loading, transport, especially on winding roads, and unloading.

The education of persons involved in handling animals, moving animals, or driving vehicles can greatly improve animal welfare. The payment of all such persons in a way which encourages rapid handling and fast driving usually results in very poor welfare and carcass quality.

6. LOADING METHODS HANDLING AND OTHER PREPARATION FOR TRANSPORT

6.1. Loading

Many studies have shown that loading and unloading are the most stressful part of transport (Hall and Bradshaw 1998). Unloading may also be stressful and the term loading, in this report, will sometimes refer also to unloading. The physiological changes indicative of stress occur at loading and last for the first few hours of transport. Then, the stress response gradually disappears as the animals become accustomed to transport. Therefore, provided transport conditions are good and the journey is not prolonged, the main welfare problems caused by transport result from loading (Broom *et al.*, 1996; Knowles *et al.*, 1995 in sheep; Christensen and Barton Gade, 1996; Schütte *et al.*, 1996 in pigs). The large effect that loading may have on the welfare of the animals results from a combination of several stressors that impinge upon the animals in a very short period of time. One of these stressors is forced physical exercise as the animals are moved into the vehicle. Physical exertion is particularly important when animals have to climb steep ramps. Second, psychological stress is caused by the novelty of being moved into unknown surroundings. Mixing unfamiliar animals often leads to an increase in aggression and this in turn causes stress (Shenton & Shackleton, 1990 in pigs; Mench *et al.*, 1990 in cattle). Also, loading requires close proximity to humans and this can cause fear in animals that are not habituated to human contact. Finally, pain may result from mishandling of animals at loading. For example, beating or poking animals with a stick, especially in sensitive areas like the eyes, mouth, ano-genital regions or belly and catching sheep by the fleece will cause pain (FAWC, 1994; Knowles *et al.*, 1994a). The use of electric goads will be painful as well.

The slope of ramps is an important aspect when loading or unloading animals. This can be measured in degrees (eg 20°) or as percentage gradient (eg 20%). The percentage gradient indicates the increase in height in metres over 100 horizontal metres. For example, a gradient of 20% means a slope of 20 in 100 (ie 1 in 5) and is equivalent to 11°.

There are important differences between species in their response to handling and loading and these should be taken into account when choosing appropriate loading procedures. For example, pigs have more difficulties than sheep or cattle in negotiating steep ramps. Also sheep, at least prepubertal sheep, do not fight when unfamiliar animals are mixed (Ruiz de la Torre & Manteca, 1999), whereas social mixing can be a serious problem in pigs (Shenton & Shackleton, 1990) and cattle (Mench *et al.*, 1990).

Differences are also found between individuals of the same species. Habituation to transport is important. Animals that have been loaded into a

vehicle before show a much less pronounced response at subsequent loadings than those that are loaded for the first time (Fernandez-Diaz, 1990 in horses). Rearing conditions and production systems also have an effect. For example, animals reared under very extensive conditions are likely to be less habituated to human contact and this may result in a bigger response during loading (Hall et al, 1998). Also, it has been shown that sheep kept indoors are less fit and respond more to physical exercise when being loaded than sheep kept at pasture (Tollesrud *et al.*, 1971). Animals that have experienced some type of environmental enrichment through contact with objects in their pen show less fear of new surroundings (Pedersen, 1992). Finally, genetic differences between individuals must be considered. Pigs that carry the halothane gene, for example, are more susceptible to the stress of loading. Differences between breeds of sheep in their responses to some stressors have also been found and are thought to have a genetic basis (Hall *et al.*, 1998b).

Despite all these differences between and within species, several general recommendations can be made. For example, even illumination and gently curved races without sharp corners facilitate the movement of the animals. Non-slip flooring and good drainage to prevent pooling of water are also important. As animals prefer to walk slightly uphill rather than downhill, floors should be flat or slope upwards. On the other hand however, ramps should not be too steep (Grandin, 2001). If the floor of the loading ramp is not slippery, there still remain differences between species in the steepness of slope which they can climb or descend safely.

6.2. Horses

The frequency, distance and method of transport to which the horse is subjected are largely dependent on the use to which a horse is put. Competition, breeding, leisure activities, sale or slaughter are common uses for transported horses. The characteristics and procedures of transportation to which horses are exposed largely depend on these uses. However, any differences in loading or other aspects of transport according to human use are not justifiable. The welfare of the horse is good or poor irrespective of human use.

Horses used for work are unlikely to travel very far from the area where they are used. Horses intended for slaughter are usually loaded in loose groups onto large stock-type trailers for transport to distant processing plants. The recreational horses include a very large diverse group of individuals that vary greatly in the frequency, distance and method of their movement. National and international trade and competitions involving athletic horses are becoming more frequent and there is a need to limit potential sources of stress during transport of horses used in sport to ensure adequate performances as well as to prevent poor welfare.

Commercial pressures in horse transport can result in poor welfare, as many studies on the behavioural, functional and pathological effects of transport stress have demonstrated.

Limited statistics are available to reflect transport in the horse industry, but the methods of horse transport have been reviewed by Houpt and Lieb (1993), Leadon (1994) and Lindner (2000), with special emphasis on sporting horses.

In fact, although there is now increasing public concern about the methods used to transport horses for slaughter, most data concern competition horses. Sporting horses are mainly transported by road or by air. Jet stalls in aircraft are becoming increasingly popular with horse owners who wish to move their horses rapidly around the world without having to wait for specialised horse charters to be organised.

Road. The Federation Equestre Internationale (F.E.I.) organises in Europe each year more than 250 events in the elite sector of the equestrian disciplines. It has been estimated that in Germany this involves over 1.5 million horse movements and in Ireland and certain equestrian sports in the United Kingdom involve over 35,000 horse movements (Leadon, 1994). More than 50,000 sport horses in Germany usually travel for more than 2 hours (Lindner, 2000). Also the Japan Racing Association registered approximately 33,500 road transport movements per year from 1993 to 1997 mainly for racing (Jones, 1999).

Athletic horses may be carried in either trailers (floats) or modified vans or lorries. Trailers are usually designed to carry two or three horses in Europe, but similar trailers can carry six, nine, or even more horses in the United States. Heavy goods vehicles are often combined with purpose-built coachwork to provide individual stall accommodations for valuable athletic horses in Europe. These vehicles may vary considerably in appearance, internal volume, and layout. They are usually designed to carry four, six, or nine horses.

Air. It is not easy to quantify the extent of horse transport by air. It has been estimated (Leadon, 1994) that major international carriers, such as KLM and Lufthansa, carry somewhere between 5,000 and 10,000 horses each year. These numbers have probably increased in recent years.

Air transport of horses utilises either a jet-stall system, in which horses travel in a fully enclosed air stable (Thornton 2000), or an open-stall system, in which there is a lesser degree of enclosure. The open stall system is usually utilised when the entire aeroplane or a considerable section of it has been chartered by a horse transport agency.

The numbers of horses that are carried in open-stall systems is determined by the type of aeroplane in which they are carried and the sizes of the horses to be transported. Three horses can be accommodated across the width of a narrow-bodied aeroplane, e.g., a Boeing 707 or Douglas DC8, in triple stalls. This number can be extended to four horses. Wide-bodied jets, e.g., a Boeing 747 or Douglas DC10, can accommodate up to seven horses across their width. Jet stalls can carry up to three horses, separated by partitions. Jet stalls are also used in charter arrangements by airlines, but they also can be used in so-called combi systems, in which passengers are carried in the front of the aircraft with freight and the horses in jet stalls carried in the rear. Passengers are separated from the freight section by a partition.

6.2.1. Preparation for transport

Interactions with humans, as well as loading and unloading procedures, cause the major problems for most animals and many physical and psychological stressors can cause poor welfare of horses during transport.

Prior to transport, handling, separation from a familiar environment and isolation from companions can strongly induce manifestations of stress, usually quantified in terms of heart rate, ACTH, cortisol and β -endorphin responses or behavioural anomalies. However, it is important to note that different stressors invoke differing responses in different animals and that these responses will vary with breed, age, sex, physiological status and previous experiences (Ferlazzo, 1995; Foreman and Ferlazzo, 1996).

Handling and transport involve two distinct types of actions by the animal: movement from one pen to another or down an alley or race and holding in a transport vehicle. Some management operations involve both movement and restraint. Other operations, such as loading onto a transport vehicle, involve primarily one type of action.

Movement towards the transport vehicle is facilitated by avoiding fear, pain or discomfort and by making the target location attractive.

Horses have monocular vision but a wide visual field due to the lateral position of their eyes which allows them to see forwards, backwards and to both sides. They depend on having some frontal vision. When they are tied this is not always possible, so caused problems.

The visual field of horses is important for handling procedures. Grandin (1979) recommended that handlers position themselves causing potential problems at an angle of 45-60° to directly behind the animals. This places the handler at the edge of the visual field, which is 300-360° in most domestic animals (Prince, 1977). To avoid strong reactions by the animal, handlers must work at the edge of the flight zone (Grandin, 1987). Entering the flight zone of an animal from behind causes the animal to move forward, whereas entering from the front of the animal causes it to back away or turn before fleeing. Horses possess some form of colour vision. Also they are usually reluctant to enter a dark area from a brightly lit one.

The acute auditory sense of horses, based on their ability to move each ear in an independent way, and on body positioning, allows horses to localise sounds in the outdoor environment, but they will be afraid of any sudden changes or any unusual circumstances around it. They may often shy because of the hollow sound made by their hooves or the flapping of flags.

Horses are herd animals and they usually maintain visual contact for social cohesion. They also copy one another and this can be very useful when it is necessary to move horses and to keep them calm in a strange environment. The maintenance of visual contact with other horses can be very effective in leading animals' movements, as well as the station inside the vehicle. Conversely, isolation often distresses horses (Haupt and Haupt 1998, Maletet 1991).

Previous experience of transport reduces fear and disturbed behaviour and physiology in horses. Whilst horses that are regularly and carefully handled and transported will show much less response to the procedures. Exposure to human contact during the sensitive period in the first weeks of life, (Miller, 1991) and gentle handling, including talking to and touching the animal, will reduce the fearfulness of the animals and improve their approachability during subsequent routine by experienced and familiar personnel. Foals handled by humans shortly after birth showed improvement in their response to handling later in life compared with non-handled animals (Waring, 1983). Tactile manipulations can be useful to relax or reassure the horse.

Horses to be transported can be separated into two groups, halter trained and untrained, or insufficiently trained. Horses that have been well trained to be individually handled by halter, should be taught loading procedures well before the day of anticipated transport, in order to reduce the stress of the first haul. If there is insufficient time for the loading training, then these horses should be treated like untrained horses when loaded and transported. Horses, such as suckling foals and youngsters, that may be led using a halter, but show behavioural disturbance during handling, need special treatment when loading and hauling in individual stalls. A moderate decrease of cortisol before the transport in experienced horses showed the importance of training (Fazio *et al.*, 1995).

Horses are sometimes restrained by tying or cross tying. A horse can be taught to be led and fully accept the pressure of a halter before tying is attempted. Then, the first tie session should be accomplished in a safe, non-confining place with halter and lead that will not break. Usually horses test the tie and try to avoid it. A safety fastener permits the horse to be easily freed in case of danger. If the point to which the horse is fastened is not higher than the horse's eyes injuries are more likely but there is some risk of injury whenever horses are tied. Cross-tying may contribute disease of the lower respiratory tract in horses (Raidal *et al.*, 1996).

Several methods of restraining horses using ropes around the animal's body are used. Most movement of horses is done by hand restraint by means of a halter and lead. There are various techniques of restraint using a chain shank put on the face, from one side to the other across the nose or through the lip, in order to control pressure in sensitive areas and obtain effectiveness. Placing the chain behind the chin applies pressure to the sensitive soft tissue there. It causes the horse to raise its head and move forward rather than stop.

Most horses will stand quietly when a twitch is applied, but this is likely to be very painful. Restraint with the lip twitch has been shown to immediately result in stress, inducing increased levels of β -endorphin (Canali *et al.*, 1996).

6.2.2. *Loading and unloading*

The horse which is disturbed when first coaxed into a transport vehicle may show various signs of disturbance, but most of these signs will disappear by, for example, the tenth time of transporting provided that the loading procedure and physical conditions, including space allowance, are

appropriate for such an animal (Broom, 1993). First time loading into a trailer is a totally new experience for the horse and results in a high level of stress, but subsequent exposure to loading is much less stressful (Fernandez-Diaz, 1990). Evasive behaviour during loading was only observed in very young horses, and the time the yearling took to load was much greater than that of 2-year-old & 3-year-old horses and those over 3 years of age; however, although mean heart rates during loading were elevated in all groups, they did not differ significantly between age groups (Waran and Cuddeford, 1995).

The transport stall and the entrance to the trailer or van must respond to the horse's behavioural requirements. The fear of unfamiliar conditions (floor, lighting, walls) will cause stress in animals. Mean heart rates are usually elevated during loading (Waran and Cuddeford, 1995). In the absence of previous experience of a vehicle, investigatory behaviour is normal. As most horses are afraid of confinement and movement into a darkened area, the ideal entrance should be wide, well lit and uncomplicated, for example with no steps or ramps. A level narrowing raceway into the transport vehicle is least disturbing. Training using positive reinforcement can be used to reduce stress during loading in horses (Houpt 1998).

The two most common types of entrances are the step-up, where the horse steps upward directly from ground level into the trailer, and the ramp type, where the horse walks up a sloped platform into the trailer.

The step-up design, preferably with a rubber bumper guard on the leading edge of the floor to prevent injury to the horse's shins, usually allows the horse to get closer to scrutinise the inside of the stall before entering. The step-up design requires the horse to learn to pick its feet up to enter, whereas the platform or ramp type, which solves the stepping up problem, may be yielding, slippery and hollow sounding to the horse's weight and step, all of which may frighten it.

Doors which swing out and sides to ramps create a funnel effect to help the horse gradually enter the more confining area the stall. Also, stall construction that allows one of the side walls to be swung wider for entry and then back into place after the horse enters is very advantageous for young and large horses. Entrances with low step-ups or very short sturdy ramps are adapted to by most horses very quickly. The longer steeper loading ramps required by high bedded vans can be dangerous unless they have sides for guiding and safety.

Horses confined in a stationary vehicle for a relatively short time (25 min) with a familiar stable-mate did not seem to show changes in heart rate or behaviour, although some horses performed a great deal of kicking and stamping behaviour whilst in the vehicle (Waran and Cuddeford, 1995). It is noteworthy that when standing in a stationary lorry, horses can begin to feed in a similar manner to that of stabled horses and have heart rates similar to typical resting levels (Waran and Cuddeford, 1995). However, under circumstances of very close confinement, exploratory behaviour soon diminishes. Confinement on the vehicle has been shown to cause significant

increases of β -endorphin and ACTH concentrations even after short transport <50 km (Fazio *et al.*, 1996).

The confinement of horses within their stalls, e.g. inside an aircraft, will lead to contamination of the environment with microorganisms. Bacterial numbers within the inhaled air can be maintained while the aircraft is in flight at levels that are comparable with those normally found in stables. Highly significant increases in bacterial numbers can occur while the aircraft is stationary. These accumulations of bacteria and other microorganisms will be inhaled and must be cleared from the respiratory system. Reduction in microorganism contamination of the environment is a gradual process that is achieved by the higher net air-flows that occur during flight.

As the horse enters the stall, a prompt, quiet and easy method is needed to close off the entry point to the stall. Many trailers and vans have very dangerous closures, including having to raise a tail gate from the ground. A simple to latch, but strong, side swinging door that closes off one stall at a time is probably effective. Where bars are used, if they are not adjustable to the height of the horse then the horse may slip under them.

In stalls and restraints horses need 0.3m or so of movement forward and back. If a horse is not accustomed to restraint by the halter, as is often the case with youngsters, then they should not be tied, but preferably be transported in a large loose box of approximately 1.5 x 2.0m.

Moreover, the practice of tying horses by their head collars in transport results in an abnormal "head held high" posture for protracted periods. Horses confined with their heads elevated for 24 hrs developed an accumulation of purulent airway secretions, increased number of bacteria in the lower respiratory tract and decreased tracheal mucociliary clearance when compared with horses positioned with their heads lowered (Raclyleft and Love, 1989; Raidal *et al.*, 1995; Raidal *et al.*, 1996). In fact, this practice may favour the spread of the normal nasopharyngeal flora into the deeper respiratory tract and facilitate the development of respiratory disease. Then, restraint of horses with their heads in an elevated position (cross-tying) during long journeys could therefore contribute to the pathogenesis of lower respiratory tract (Oikawa *et al.*, 1999).

Horses confined in the single stall of a horse trailer or the "horse box" used in air shipment are severely restricted in the range of motion and amount of movement. They are also performing varying amounts of isometric exercise. This contrasts with the normal living conditions of an endurance horse that usually is kept in large paddocks or pastures. This restrictive confinement of normally free-moving fit athletes predisposes them to myositis (Foss, 1999).

The orientation of the horse in the box, facing to the front or rearward, has been considered an important psychological factor, both with respect to differences between stationary and moving vehicles and to social cues during the journey and it has been studied in experienced racehorses (Slade, 1987) and in transport naïve yearlings (Clark *et al.*, 1988).

Different effects on moving or stationary horses have been reported. It has been suggested that rear ward facing of horses in two-horse trailers and in lorries may result in more relaxed behaviour than forward facing . The average heart rate of horses transported in pairs in a lorry over a standard one-hour route was significantly lower when the horses were transported facing backwards and they also tended to rest on their rumps more. In the forward-facing position, the horses moved more frequently and tended to hold their necks in a higher than normal position and to vocalise more frequently. It was concluded that horses seem to find being transported less physically stressful when they were facing backwards than they were facing forwards (Waran *et al.*, 1996).

In a study of 16 same-sex pairs of yearling horses naive to transport, it was noted that rear-facing horses had fewer impacts against the trailer sides, fewer total impacts and fewer losses of balance and that they tended to have lower heart rates during the first 15 seconds of travel. However, the investigators concluded that orientation had no major effects on physiology; despite this, body orientation during transport may be an important stressor for some, although not all, horses (Clark *et al.*, 1993).

It has been hypothesised that horses have a preference for facing backward in a trailer during road transport in order to minimise shifts of body weight due to acceleration and decelerations. It was recorded that horses spent significantly more time facing backward when the trailer was in motion, but not when it was parked. Several horses displayed strong individual preferences for the directions they faced during road transport (Smith *et al.*, 1994a). Heart rates were not significantly different between horses facing forward or backward during transport or while parked (Smith *et al.*, 1994b). Recently it has been demonstrated that certain horses have a superior ability to maintain balance in a particular orientation. Thus, it was confirmed experimentally that individual characteristics and other factors may play a larger role than orientation alone in the ability of horses to maintain balance during transport (Toscano and Friend, 2001).

There was a difference in the body posture of horses during transport compared with that in a stationary vehicle (e.g. forelegs forward and apart and hindlegs apart). They changed position very little during transit and remained in a bracing posture throughout the journey. In addition heart rates during transport were consistently higher than when the horses were in a stationary vehicle (Waran and Cuddeford, 1995).

6.3. Pigs

Many studies have shown that loading and unloading are the most stressful parts of transport and many studies have shown that heart rate increases at loading and then gradually falls as the pig becomes accustomed to the transport, only to rise again at unloading (e.g., Bradshaw *et al.*, 1996, Christensen and Barton Gade, 1996, Schütte *et al.*, 1996). These changes are a combination of physical effort as pigs are moved to the vehicle and the psychological effects of being removed from the home pen to novel surroundings, being mixed with unfamiliar individuals etc. As a species, pigs have particular difficulty in negotiating slopes and those individuals that

carry the halothane gene are more susceptible than those without the gene. All efforts must therefore be made to reduce stress levels, particularly physical exertion, at loading.

6.3.1. *Preparation for transport*

Since the halothane gene results in much greater adverse effects of transport, an important preparation for transport involves checking for the presence of this gene and either avoiding transport or taking special care if it is present. Research on the exposure of pigs to a limited and practicable amount of early handling shows that this can significantly reduce responses to pre-transport handling which are associated with poor welfare. In addition such early handling makes the job of those who have to move pigs considerably easier (Hemsworth and Coleman 1998). Hence it is clearly desirable for such handling to become normal practice in the pig industry. It would seem that, in general, this has not been done.

Pigs can be taken directly from the home pen to the transport vehicle but it is increasingly common to have an indirect transfer, where pigs are held away from the main herd for a period before being loaded onto the transport vehicle. In this way the spread of disease via the driver and transport vehicle is considerably reduced. It is important that the conditions in these holding areas are appropriate and take account of animal welfare requirements.

Indirect transfer systems can be situated immediately adjacent to the farm building and, depending on the time the pigs will spend in the area, can vary from a simple system for short term holding to a completely covered building with separate ventilation and drainage systems for long term holding. For herds of especially high health status, such as SPF herds, mobile delivery systems are used, where the producer loads pigs for slaughter onto a container (trailer) and leaves this at a predetermined place and time for transfer to the transport vehicle proper. Irrespective of system used, if pigs are not kept in their original group until loading takes place, fighting amongst animals occurs. This means that the system should consist of small pens to keep unfamiliar pigs separate. Danish industry recommendations for space requirements for these areas are for slaughter pigs up to 110 kg are:

- 0.45 m² per pig for holding periods below half an hour.
- 0.55 m² per pig for holding periods up to 3 hours.
- 0.65 m² per pig for longer holding periods.

0.65 m² corresponds to the space allowance for pigs of 85-110 kg in pig housing, as described in Directive 91/630/EEC of 19 November 1991. The other values are arbitrary figures that allow a progressively smaller space allowance for shorter holding times.

6.3.2. *Loading*

Using pigs of 40-70 kg live weight Warriss *et al.*, (1991) showed that, between 0° and 20°, slope appeared to have little effect on the time taken for pigs to ascend and descend a ramp. Above 20°, however, the time taken to

ascend increased linearly. With slopes above 20°, the time taken to descend was biphasic with times increasing substantially above 35°. Pigs took longer to climb steep slopes with inter-cleat distances of 300 mm between the centres than with 150 mm, whereas there was no effect of cleat placement on descending. Preference tests with pigs of approximately 16 kg. live weight (Phillips *et al.*, (1988) showed that ramp use steadily decreased with increasing slope angle from 20 to 32° and that the number of pigs refusing to use the ramp increased from 2 % at 20° to 44 % at 32°. Cleat spacing also affected ramp use with the smallest spacing (50 mm) being the most preferred. Cleat heights (10 to 40 mm) had no consistent effect on ramp use. The authors stated that slopes below 20° would in all probability have had a favourable effect on ramp use but that in their particular area (pig housing design), 20° was the lowest slope that was practicable.

The small amount of evidence available implies therefore that slopes should not exceed 20° for pigs and practical experience shows that 9° is good for pigs and handling staff although smaller angles would be preferable. There are technical solutions that completely eliminate the need for slopes at loading and that are in use in many European countries (Christensen *et al.*, 1994) and these should be phased in throughout the Community for pigs. Options vary from tail gate lifts of various types and mobile decks on multi-tiered transport vehicles to ramps adjusted to vehicle heights at farms. Irrespective of the system chosen, pig movement is easier if the width of driveways to the transport vehicle or lift is sufficient for two or three pigs to walk side by side. Narrowing of the driveway will cause blockages and impede forward movement.

Electrical goads are strongly aversive to pigs and increase heart rate by a factor of 1.5 (van Putten and Elshof (1978). They are also associated with an increased level of carcass damage, when used at loading (Guise and Penny, 1989).

6.3.3. *Un-loading*

As with loading, slopes of more than 20° cause problems and options that eliminate slopes will reduce stress and the risk of injury to pigs. For slaughter pigs, options can be adjustable ramps or the use of scissor lifts at abattoirs that can be raised to the height of the vehicle floor. There are problems unless the whole of the back of the vehicle is open at un-loading. Movements of small groups of pigs are easier because the driver can reach all pigs in the group without difficulty so welfare is better if compartments are un-loaded one by one. The use of electrical goads can stress pigs to such a degree, that they repeatedly try to return to the transport compartment rather than leave the vehicle. Contrary to expectation, the use of goads increases the time necessary to off-load a vehicle compared with a calm un-loading of compartment pens without goads. Other means of guidance such as light weight driving boards can be used instead.

For multi-tiered vehicles, it is highly desirable that the height of each deck can be adjusted on arrival at the final destination so that the haulier can enter the vehicle to guide the pigs out. This is particularly a problem with three-tiered vehicles. Moreover, the use of mobile decks means that there will be a

height difference making a step between the deck and the un-loading ramp corresponding to the thickness of the deck floor(s). The effect of step height differences at loading and un-loading on ease of pig movement off multi-tiered vehicles has not been reported in the literature but experience shows that when step height are above 15 cm some pigs hesitate to leave the vehicle voluntarily. It is important that the un-loading ramp is non-slip, lighting arrangements are appropriate and the whole of the back of the vehicle is available for un-loading.

6.4. Sheep

Animals from different groups or flocks are often mixed as a preparation for transport. Mixing of unacquainted animals leads to an increase in aggression in pigs (Shenton and Shackleton, 1990) and cattle (Mench *et al.*, 1990). The situation in sheep, however, may be different. Ruiz de la Torre and Manteca (1999) found that social mixing actually decreased the total number of aggressive interactions, probably because these were directed preferentially to flock mates. This study however was done with prepubertal animals and its results may not be extrapolated to mature animals, particularly males. Hall *et al* (1998b) also concluded that social mixing is less of a welfare problem for sheep than for other farm animals.

Habituation to being handled by humans can reduce the stress response to loading and unloading. Hall *et al.* (1998b) studied the effects of taming or habituation to handling on the responses of sheep to transport and showed that individual animals responded differently to taming and that those sheep which responded most positively to taming showed the least marked response during transport.

Loading, unloading and the early stages of a journey are the most stressful aspects of transport (Knowles, 1998). For example, Broom *et al.* (1996) found that during a journey of 15 hours, the major physiological changes that were indicative of stress occurred in the first hours. It is therefore important that measures are taken to improve the welfare of the animals at these stages.

Sheep are better able to cope with steep ramps than cattle or pigs. However, when the ramps do not have side barriers, sheep may be pushed or jump over the edge. It is important that there are few shadows that might frighten the animals, and that the lighting inside the vehicle is good, as sheep are reluctant to move into dark places (Knowles, 1998). If sheep are caught by the fleece alone, this will cause pain and may result in bruising (FAWC, 1994; Knowles *et al.*, 1994a). Indeed, Cockram and Lee (1991) found a correlation between the frequency of wool pull and bruising.

6.5. Cattle

6.5.1. Preparing cattle for transport

When calves are kept individually in crates they show greater adrenal and other responses to handling and loading into vehicles than if they have been kept in social groups (Trunkfield and Broom 1991). Hence giving animals

social experience improves welfare during loading and transport. Appropriate previous exposure to humans can also make handling easier and reduce aversive responses to humans during handling, sometimes many months later (Le Neindre et al 1996).

6.5.2. *Handling facilities for cattle*

Cattle have practically panoramic vision but their binocular visual field is narrow so they have poor depth perception. They are therefore prone to confuse shadows and floor irregularities with physical barriers or solid objects. They may be reluctant to cross such areas. Movement is therefore facilitated by even illumination, and race systems that eliminate visual distractions and promote the animals' natural following behaviour. These systems are likely to have high solid walls. Gently curved races without sharp corners can prevent animals from seeing dead ends and thus baulking. Non-slip flooring is important, as is the positioning of the stockmen handling the cattle. The design of the handling system needs to allow for this. To promote movement the handler needs to maintain a position just inside the so-called "flight zone" of the animal and within an angle of 45°-60° behind a line at right angles to the animal's shoulder, or, in a group of animals, the leading animal's shoulder.

Animals prefer to walk slightly uphill rather than downhill. Floors therefore need to slope upwards or be flat. There needs to be good drainage to prevent pooling of water, which can cause a visual distraction and promote slipping. Slippery floors and slipping cause stress in cattle (Cockram & Corley, 1991, Grandin, 1998).

Some problems can occur with any ramp and the use of ramps attached to vehicles can be avoided. Eldridge *et al.*, (1989) found that Australian cattle moved more freely, and with less slips, through 120cm wide unloading races and those with a 20% slope, than through narrower (70cm) races or with a 33% slope. A slope of 33% makes an angle of 18° with the ground; one of 20% an angle of 11°. The authors recommended that wide ramps with slopes of not more than 20% (11°) should be used for loading and unloading cattle transport vehicles. Lapworth (1990), based on observations of handling Australian cattle, recommended a maximum slope of 20° but pointed out that the internal ramps used in livestock transporters had a slope of 28° and this seemed to work in practice. Grandin (2000), from her experiences principally in the USA, suggested the maximum angle for livestock unloading ramps should be 20-25°. However, she recommended a maximum angle of 15° for the ramp leading to the stunning box or stunning restrainer. The implication from these reports is that a maximum slope for cattle of 11° would be best, but slopes up to 20-25° might be climbed without significant problems for the animals under certain conditions, for example if all other factors were optimised. This would include non-slip floor coverings, probably including cleats at 20-30cm intervals. For concrete ramps Grandin (2000) recommended stair steps with a 10cm rise and a 30cm tread, rather than simple slopes. For Australian cattle Lapworth (1990) recommended a 10cm rise and a 50cm tread. The risk of falling, when an animal in a group makes a sudden movement, is increased on all slopes steeper than 20°.

Many vehicle loading ramps are formed by the tailgate and are therefore as wide as the vehicle (about 300cm). However, Lapworth (1990) recommended relatively narrow (76cm) ramps for loading, effectively forming a single race, to prevent animals turning round, but wide (300cm) unloading ramps to facilitate ease of movement off the vehicle.

6.6. Conclusions

Horses, cattle, sheep and pigs have well developed senses and learning ability. The ability to feel pain and the neural mechanisms of pain perception are similar to those of other mammals. They are highly social animals. They show behavioural and physiological responses to isolation, strong responses to other group members and they are frightened by unfamiliar situations and sounds.

When pigs or adult male cattle are mixed with unfamiliar animals from other pens on the same or different farms, before or during transport, the animals may fight, there may be considerable fear and injury in some individuals, the meat may become dark, firm and dry and, in each of these circumstances the welfare will be poor. There can also be adverse effects of social mixing in calves and some horses and rams.

For most livestock transport, loading, with associated handling or driving, is the most stressful part. The disturbing aspects may be fear, pain caused by humans, forced physical exercise especially on steep ramps, and stress caused by the unfamiliar loading procedure, vehicle conditions and social contacts. Poor welfare during loading is evidenced by animals, stopping, turning and being difficult to drive, fear vocalisations, high heart rate, high cortisol concentration in plasma or saliva and high concentrations of other hormones such as β -endorphin, prolactin and vasopressin.

The use of a twitch, a thin rope twisted around the soft tissue in the region of a horse's nose, for facilitating horse handling prior to or after transport, probably causes severe pain on all occasions. Beating or poking with a stick will cause pain to farm animals, especially in very sensitive areas like the eyes, mouth, ano-genital regions or belly. When sheep are lifted or moved bodily by a human grasping them by their wool, substantial tissue damage is caused in the region grasped and this must be associated with considerable pain. Electric goads can cause severe fear and pain and their use is associated with poor meat quality in pigs and other species.

Species vary in their responses to loading. Pigs are more readily affected by physical exercise whilst sheep are easily frightened by humans. Each species requires different handling procedures. Genetic strain also affects responses to loading and transport, for example all modern pig strains are adversely affected by the loading and transport and some strains, such as those carrying the halothane gene, are severely affected.

If animals have experience of loading and of transport under good conditions, they are likely to show much reduced responses to subsequent loading and transport. Horses which are frequently transported and sheep which have been transported on several occasions show fewer indications of poor welfare. Previous exposure to calm, friendly humans during rearing, even for short

periods, reduces poor welfare during loading and transport. Animals with little previous human contact, or with experience of ill-treatment, are the most adversely affected by human handling and loading.

Horses can mount a step-up entrance to a transport vehicle but animals which have not had previous experience of such an entrance may balk. For horses which have not been loaded into a vehicle before, a ramp no steeper than 20° to the horizontal is less likely to cause problems.

Pigs, especially old sows, can have difficulty climbing any ramp, although 70-120 kg pigs can usually climb a non-slippery ramp of 9° fairly easily. Ramps which pigs are required to climb cause substantial difficulty if they are steeper than 20°.

Sheep are readily frightened by poorly designed ramps, e.g. those without solid sides or which are slippery. Most sheep can climb steep slopes but slopes of more than 20° may lead to injury when sheep show a panic response.

A maximum ramp angle of 20° is appropriate for cattle providing it has non-slip floors and appropriate cleats at 30 cm intervals. Calves, especially those which have had little exercise, require lower gradient loading ramps.

7. SPACE ALLOWANCE

7.1. General introduction:

The amount of space allowed for an animal during transport is one of the most important factors influencing its welfare (Hall and Bradshaw 1998). The topic is particularly sensitive because costs can be lowered by reducing the space. In general, smaller space allowances lead to lower unit costs of transport since more animals can be carried in a vehicle of any particular size. Space allowances have two components. The first component is the floor area available to the animal to stand or lie in. This equates to what is usually referred to as stocking density. The second component is the height of the compartment in which the animal is carried. With multi-decked road vehicles this may be especially important because there are practical constraints on the overall maximum height of the vehicles, for example to enable them to pass under bridges. For this and financial reasons there are sometimes efforts to reduce the vertical distance between decks (deck height), and therefore the volume of space above the animal's heads. This reduction may adversely affect adequate ventilation of the inside of the compartment in which the animals are held.

Absolute minimum space allowances are determined by the physical dimensions of animals (Petherick 1983). However, acceptable minimum allowances will be dependent on other factors as well. These include the ability of the animals to thermoregulate effectively, ambient conditions, particularly environmental temperature, and whether the animals should be allowed enough space to lie down if they so wish. Whether animals want to lie down may depend on journey length, transport conditions, especially whether it is comfortable to do so, and the care exercised in driving the

vehicle and its suspension characteristics in relation to the quality of the road surface. A very important consideration in establishing practical minimum space requirements is whether the animals need to be rested, watered and fed on the vehicle. Resting, watering and feeding on the vehicle will require lower stocking densities to enable the animals to access feed and water. Space allowances may need to be greater if vehicles are stationary for prolonged periods to promote adequate ventilation, unless this is facilitated and controlled artificially.

When four-legged animals are standing on a surface subject to movement, such as a road vehicle, they position their feet outside the normal area under the body in order to help them to balance (Broom 2000). They also need to take steps out of this normal area if subjected to accelerations in a particular direction. Hence they need more space than if standing still. When adopting this position and making these movements on a moving vehicle, cattle, sheep, pigs and horses make considerable efforts not to be in contact with other animals or the sides of the vehicle. Over the range of space allowances used in animal transport, provided that vehicles are driven well, the greater the space allowance, the better the welfare of the animals. However, if vehicles are driven badly and animals are subjected to the substantial lateral movement which results from driving too fast around corners, or to violent braking, close packing of animals may result in less injury to them. The best practice is to drive well and stock in a way which gives space for the animals to adopt the standing or lying position which is least stressful to them.

A separate problem which is linked to space allowance is inter-animal aggression or potentially harmful mounting behaviour. Pigs and adult male cattle may threaten, fight and injure one another. This results in poor welfare and potentially DFD meat (Lambooy 2000). Rams and some horses may also fight. Such fighting is minimised or avoided by keeping animals in the social groups in which they lived on the farm, or by separating animals which might fight. Groups of male animals may mount one another, sometimes causing injuries in doing so. At very high stocking densities, fighting and mounting are more difficult and injuries due to such behaviour may be reduced. However, problems of mounting and fighting can be solved by good management of animals. Keeping animals at an artificially high stocking density, in an attempt to immobilise them, will result in poor welfare.

Floor space allowances need to be defined in unambiguous terms. In particular, stocking densities are best defined as m^2 floor area per animal of a specified live weight, e.g. ($\text{m}^2/100\text{kg}$), or kg live weight per m^2 floor area (kg/m^2). Stocking rates, such as m^2 per animal (m^2/animal), are not an acceptable way of defining floor space requirements since they take no account of variation in animal weight. Definitions of acceptable space allowances ideally refer to the whole range of animal sizes (live weights) to be encountered, preferably using a formula (Broom 2000). A problem is that information applicable to very small or very large animals is sometimes not available. Moreover, the relationship between minimum acceptable space allowance and animal weight is often not linear. Determining appropriate minimum acceptable space allowances for transported animals relies on several types of evidence. These include evidence based on first principles

using measurements of the dimensions of animals, evidence based on behavioural observations of animals during real or simulated transport conditions, and evidence based on the measurement of indices of adverse effects of transport. An example of the latter kind of evidence would be the amount of bruising on the carcass or the activity of enzymes such as creatine kinase (CK) in the blood.

For an animal of the same shape, and where body weight is W , linear measurements will be proportional to the cube root of W ($\sqrt[3]{W}$). The area of a surface of the animal will be proportional to the square of this linear measure ($(\sqrt[3]{W})^2$). Algebraically this is equivalent to the cube root of the weight squared ($\sqrt[3]{W^2}$), or weight to the power of two-thirds ($W^{2/3}$ or $W^{0.67}$). This is the origin of the exponent in equations such as that suggested by the UK Farm Animal Welfare Council (1991) for the minimum acceptable area for all types of animal:

$$A = 0.021 W^{0.67}$$

where A is the minimum floor area required by the animal in m^2 and W is the weight of the animal in kg. The constant in the equation (0.021) depends on the shape of the animal, in particular the ratio of its body length to its body width.

The principle that animals should be provided with adequate space to stand or lie in their natural position to allow thermal comfort and prevent injury or suffering to themselves, and the space allowance and height of compartment for average weight and the different category of animals, are established by the Directive 91/628/EEC.

7.2. Horses

7.2.1. Floor allowance

Horses stand for much of the day and can sleep whilst standing. During transport in good conditions with good driving, horses stand. They may lie down, if given quiet spacious conditions, after long journeys, e.g. more than 12 hours.

Pregnant females need approximately 10% more space in the last third of gestation. For journeys lasting more than 4 hours, foals and young horses need to have sufficient space in which to lie down.

Very few data in the literature concern stocking density during transportation of horses.

Responses of horses to trailer design, duration and floor area during commercial transportation to slaughter with distances ranging from 596 to 2,496 km have been studied (Stull, 1999). A mean weight loss of 4%, a greater percentage of injured horses following transport in straight-deck trailers, muscle fatigue and dehydration, especially in journeys over 27 hrs, were recorded. However, most physiological responses to transportation were less in horses provided with a greater floor area.

Three groups of slaughter-type horses were used to determine stocking density effects on displacement (distance moved during a stop), falls and injuries. High stocking density (1.28m²/horse) of horses during transport increased the incidence of falls and injuries as compared with 2.23m² per horse, and made it more difficult for a horse to get up when it had fallen. Average displacement was not different at 1.28 or 2.23 m²/horse (Collins *et al.*, 2000).

7.2.2. Height

Directive 91/628/EEC states that “Animals shall be provided with adequate space to stand in their natural position”. A horse needs space to use its head and legs to balance during the motion of the transport vehicle. For good ventilation and freedom of movement, a minimum internal height of the compartment of the maximum height of the withers + 75 cm is needed.

Designing the front of the stall to allow the horse to lower its head, at least to shoulder height, has been shown to be important to normal respiratory function during journeys of more than a few hours (Racklyeft and Love, 1990). Transport stalls may have head ties and chest bars that require the horse to maintain its head at 0.25 m or more above the shoulder. These researchers recommended that feed, including hay, be maintained at shoulder level or below.

7.2.3. Interference with other factors

Temperature, humidity and ventilation are the most crucial factors affecting the welfare of horses transported over long distances.

Thermoregulation is critical for horses (McConaghy *et al.*, 1994). In the absence of wind or moisture they readily survive temperatures down to -20C (even to -40C if given shelter), but horses are most comfortable in mild temperatures in the range 10-20C. Shade from direct sunlight is normally sought by horses, in temperatures over 25C if there is no air movement. A combination of cold and wind, especially in wet weather, is stressful for a horse.

Horses naturally rely much on cutaneous evaporation as a mechanism for heat loss. Increases in ambient heat and especially humidity may further hinder their ability to thermoregulate as compared with species which rely more on increased respiration (panting) for heat loss.

Horses have a large ratio of body mass: skin surface area, and heat exchange at the skin level becomes less efficient as this ratio increases. Increased humidity makes dermal evaporation less efficient. Moreover, increased muscular activity results in increased heat production. Further fluid loss and some evaporative heat loss via the respiratory tract occur when horses increase their respiratory rate (Kohn and Hinchcliff, 1995). Convective heat loss in horses occurs from wind movement across the front and side of the horse, and it can be increased at rest by the use of fans blowing across the horse during rest periods (Bradbury and Allen, 1994). Conductive heat loss can be increased, e.g. by application of water, cooler than the skin, to the horse's exercised muscles, thus allowing direct contact and direct heat transfer due to the gradient between skin and cool water. Radiant heat gain can occur

from the sun shining on the horse's skin. It has been clearly demonstrated that increased heat and humidity severely impair horses' abilities to continue to perform endurance exercise safely (Foreman, 1996). During treadmill tests (Geor *et al.*, 1995; McCutcheon *et al.*, 1995a), hot and humid laboratory conditions led to an increased rate of change in core temperature, increased middle gluteal muscle temperature, decreased core: skin temperature gradient, and increased heart rate throughout the test. Hot and humid conditions also increased the rate of heat storage and delayed heat dissipation after exercise, probably as a result of a decreased core: skin temperature gradient.

The Scientific Committee on Animal Health and Animal Welfare adopted on 8 December 1999 a report on the Standards for Microclimate inside Animal Transport Road vehicles. Several recommendations were made although not specifically concerning horses. In particular the reports advised that all vehicles should have a temperature and humidity monitoring system, a warning system and a means of recording this data. The ventilation system should also be capable of operating independently of the vehicle engine. Ranges of minimum and maximum temperatures were also suggested.

Leadon (1998) concluded that adaptation of the stall to prevent exposure to extreme temperatures is necessary if the ambient temperatures is $>25^{\circ}\text{C}$ or $<10^{\circ}\text{C}$.

Confinement of horses within their stalls may lead to contamination of their immediate environment with microorganisms. A large number of airborne microorganisms present in the transport vehicle during transportation could be inhaled, thereby inducing respiratory disease (Leadon *et al.*, 1990). Moreover, the desiccating effects of exposure to dry air while in a vehicle in motion may result in diminished mucosal clearance mechanisms in the airways (Leadon, 1994). The challenge to the respiratory system will be increased where both the number of microorganisms and the relative humidity are increased, as occurs in stationary aircraft. Thereafter, mucociliary clearance of inhaled particles may be reduced as a result of the desiccating effects of exposure to dry air and low relative humidity.

Temperature and humidity have therefore the potential to act as stressors of the respiratory system. Changes in temperature with net increases in relative humidity and contamination by microorganisms occur in the road transport of horses (Leadon, 1994). Allergens play an important role in this.

Air temperature and relative humidity will be higher in an aircraft when it is stationary during loading or unloading, and during stops for refuelling, than when it is airborne. The air within an aircraft while it is at altitude flows from the front to the rear of the cargo space. This air is much cooler and drier than that which is present on the earth's surface. There is therefore a temperature and relative humidity gradient from the front to the rear of the aircraft. This gradient tends to be maintained even when the aircraft is on the ground during loading and unloading or refuelling stops. This occurs because the ground power units and air-conditioning systems used by stationary aircraft also promote a front to rear airflow. This variation in temperature and relative humidity reflects the inability of the flight deck crew to provide a uniform environment for horses in transit on fully loaded aircraft. This may be of

clinical significance in that variations in environmental conditions can be an additional stressor that horses succumbing to shipping fever should be spared, if possible. This is the reason for the recommendation that wet- and dry bulb thermometers should be placed within the cargo hold and monitored on an hourly basis throughout all medium- and long-haul flights (Leadon, 1994).

Oikawa *et al.*, (1995) reported measurements of the transport vehicle interior environment during a 41-h journey. Horses were loaded four to a truck, had free access to hay throughout the journey and were offered water during rest periods. In this study, the concentration of ammonia gas emitted from the build up of excreta in the vehicle increased in proportion to the duration of transport. There was no relation between atmospheric dust concentration and travel time.

Smith *et al.* (unpublished data reported by Jones (1999) evaluated the effects of different combinations of windows and vents on the washout of gases from an enclosed two-horse trailer. They found that retention of gases in the trailer can be modified by altering the flow environment into and out of the trailer, particularly by opening and closing the doors at the rear of the trailer. However, minimal changes in the interior airflow pattern and washout resulted from opening and closing of windows and vents.

A study was conducted to investigate the effect of purification of the air environment inside the vehicle on horses. In the first group, hay was suspended in front of each horse and accumulated droppings and urine were not removed. In the second group, there was no suspended hay and droppings and urine were removed and washed out at each rest period. A comparison was made of two groups on the changes in the interior environment of the vehicle. There were marked increases of aerial ammonia concentrations, amounts of airborne dust and microorganisms in the first group's vehicle compared with those of the second group, leading to related increases of indicators of inflammation (serum leucocyte counts and fibrinogen), that increased with travel times (Oikawa *et al.*, 1999).

Physiological responses of horses to 24 hours of transportation using a commercial van during summer conditions clearly show changes in muscle metabolism, stress indices, dehydration and immune parameters, and body weight (Stull and Rodiek, 2000).

The effects of the microclimate on horses during international air transportation (12 h and 24 h) in an enclosed container were studied (Thornton, 2000). Heart rates during the flights reflected any agitation of the horses, unless in association with take-off and landing, but there were no changes in haematological or blood biochemical values.

7.3. Pigs

7.3.1. Introduction

The provision of adequate space allowances during pig transport involves giving pigs sufficient space to carry out necessary functions, such as resting, drinking and feeding. This means that appropriate stocking densities will be dependent on the journey length and whether resting, watering and feeding

are necessary. Many pigs have some degree of leg disorder which results in much greater difficulty in standing during vehicle movement in this species than in other ungulates. Old sows and heavy animals have the greatest problems in this respect. If the vehicle is driven well all pigs will lie down during transport given sufficient space. The pigs lie down shortly after loading (Bradshaw et al 1996a, Broom 2000). Guise *et al.*, (1990) found that the mean journey length of 86 transports of British slaughter pigs was 71 miles with a variation from 2 to 236 miles (average 114 km and variation 3 to 378 km respectively). Christensen *et al.* (1994) confirmed that in seven European countries the majority of journeys of pigs to were slaughter less than 100 km in length. Although journey lengths are less well known for breeding pigs and pigs for further fattening, a similar situation is likely to occur (Colleu et al 1999). For example, statistics from the Danish SPF system show that only 3.6 % of four million 30 kg pigs had journeys longer than 100 km. For 7 kg pigs the figures show a bimodal distribution with maxima at approximately 25 and 105 km. 21.9 % of 598,080 7 kg pigs had journeys longer than 100 km in 1999/2000. Longer distance transports of pigs are therefore the exception rather than the rule and the majority of journeys will not include resting periods or the necessity of watering and feeding on the way.

Slaughter pigs: Research with slaughter pigs with journey times up to three to four hours has shown that with space allowances of the order of 0.30-0.31 m² per 100 kg pig (323-333 kg/ m²) CK levels are elevated (Lee *et al.*, 2000, Warriss *et al.*, 1998) and there is evidence of rectal prolapse and a higher incidence of skin damage (Guise and Warriss, 1989). At this space allowance not all pigs will be able to stand on all four feet at one time and there will be continuous disturbance as individual pigs try to reach the standing position.

In the range 0.35-0.50 m² per 100 kg pig (200-286 kg/m²), blood parameters, such as cortisol, CK, and lactate show trends for change with stocking density but these are not significant (Barton Gade and Christensen, 1998, Barton Gade, 2000, Lee *et al.*, 2000, Warriss *et al.*, 1998). Barton Gade (2000) showed that cortisol levels at sticking were not affected by space allowances of 0.34 to 0.49 m² per 100 kg pig on journeys of three to three and a half hours, when pigs were sent for immediate slaughter without lairage. However, since all these animals showed higher cortisol concentrations than non-transported pigs, the lack of discrimination amongst stocking densities is not of great significance. Indeed, for cortisol and β -endorphin, the effects of space allowances of 0.31 m² per 100 kg pig were not significantly different from higher space allowances (Warriss *et al.*, 1998). The same authors showed that in pigs fasted 9-14 hours prior to loading, there was no effect of space allowance on characteristics measuring dehydration for an average journey time of 2 hours 59 min. (range 2 hour 30 min. to 3 hours 51 min.). However, no information on environmental temperatures during transport was given. The authors noted that the fact that blood samples had been taken at sticking after a lairage time of one hour may have affected the results obtained. Lairage would have tended to reduce any differences caused by transport.

In the study of transport conditions in seven EU countries (Christensen *et al.*, 1994) space allowance had no effect on transport mortality. This was mainly

affected by the genetic make-up of the pig population concerned and countries with a high incidence of the halothane gene had higher transport mortality figures than countries, where the halothane gene was essentially absent. There is some evidence that lower space allowances can give a higher mortality figures in pigs (see review by Warriss, 1998). However, these results may have been affected by overheating due to inadequate ventilation in the vehicles used. Inadequate ventilation clearly has a negative effect on transport mortality (see section 7.3.1).

Similarly, meat quality characteristics such as ultimate pH, colour, drip loss and water holding capacity are unaffected by a wide range of space allowances (Barton Gade, 2000; Barton Gade and Christensen, 1998; Guise *et al.*, 1998; Nanni Costa *et al.*, 1996; Warriss *et al.*, 1998). Skin damage scores have sometimes been affected by space allowance. Guise and Warriss (1989) showed that a low space allowance led to increased skin damage but Guise *et al.*, (1998) could not confirm this finding over a wide range of space allowances. Similarly, Barton Gade and Christensen, (1998) found least skin damage with a space allowance of 0.35 m² per 100 kg pig in one study but not in a second study (Barton Gade, 2000). Skin damage can be due to either pigs treading on one another or to aggression and, when entire males are included, to mounting activity. Variations in these behaviours, particularly the propensity of pigs to fight, may be the reason for this lack of consistency.

Fighting is minimised if unfamiliar pigs are not mixed. The results reported on the effect of space allowance on the willingness of pigs to lie during a journey are affected by variables such as vehicle movement. Giving pigs more space to lie down has not always been found to lead to them doing so, especially on shorter journeys. Lambooij and Engel (1991) found that on longer journeys, the percentage of pigs lying down increases as the journey progresses and that at the lowest space allowance (0.35 m² per 100 kg pig) fewer pigs lay down after 11 hours transport than at 0.42 and 0.53 m² per pig. Bradshaw *et al* (1996) reported that pigs spent most of their time lying down but not Bradshaw *et al.*, (1996b) because there was much lateral movement and braking during that journey. Guise and Penny (1992) and Guise *et al* (1996) reported that standing was the most common posture irrespective of space allowance (0.31-0.50 m² per 100 kg pig) again on commercial journeys with normal rather than careful driving. Vehicle movement effects on the animals were probably the reason why Barton Gade and Christensen (1998) and Barton Gade (2000) found that significantly more pigs were sitting or lying at lower space allowances (variation 0.35-0.50 m² per 100 kg pig on transports up to just over 3 hours. With a space allowance of 0.35 m² per 100 kg pig the Danish work showed that all pigs can stand and can move amongst one another, albeit with a certain amount of difficulty. At 0.39 m² and higher space allowances, pigs can easily change position, but they have difficulty in keeping their balance, as the vehicle negotiates bends too fast, brakes suddenly, etc. A higher space allowance also makes it easier for pigs which have been mixed to fight during transport (Barton Gade unpublished material, Bradshaw *et al* 1996b). There is no doubt that some of the variation seen between research results is due to the standard of the vehicles used and the roads traversed during the journey.

In Barton Gade (2000) sudden braking, pauses and other factors led to a rougher journey than would be normal for routine Danish transports and a recent survey of pig posture for routine transports with a space allowance of 0.35 m² per 100 kg pig showed, that for transports of one to just over two hours on average 83-85 % of the pigs were lying or sitting on arrival at the abattoir and that of these 58-63 % were lying.

Warriss *et al.*, (1998) found little evidence of an adverse effect on pig welfare down to a space allowance of 0.36 m² per 100 kg pig except that the pigs could not lie down. The mean journey time in this research was three hours.

It should be noted that the above scientific work carried out on slaughter pigs transported for under four hours used breed combinations with a low incidence of the halothane gene at maximum environmental temperatures in the Danish work of 26 C. Steffens (1999) showed that halothane positive pigs showed the same increase in heart rate at loading as heterozygote pigs but that the heart rate remained at loading levels throughout the transport, whereas heterozygotes showed a decrease but to a level higher than the home pen level as transport progressed, as is typical for pig transport. Space allowances may have to be increased for pig populations with the halothane gene and for transport at higher temperatures. However, more work is necessary before actual values for appropriate space allowances under these conditions can be given.

Warriss *et al.* (1998) also noted that a higher space allowance was necessary to allow all pigs space to lie down. Warriss (1998) proposed on the basis of a literature review that 0.40 m² per 90-100 kg pig was an appropriate figure for space allowance during transport. The figure of 0.42 m² per 100 kg pig was proposed by Lambooij *et al.* (1985) for two-day transports with watering but not feeding.

When 100 kg pigs are given 0.35-0.42 m² per pig, they will sometimes lie down with most animals lying on the sternum and some animals lying so that they overlap the bodies of others. On other occasions, with this space allowance range, some or all of the pigs remain standing. Contrary to the general view of the Working Group the view was expressed by one member that a space allowance for a 100 kg pig of 0.35 m² is acceptable for shorter journeys as pigs quite frequently lie overlapping with others. However, others were concerned that there would be many occasions at this space allowance when a significant proportion of pigs would not be able to lie down or would have to lie in the less-preferred sternal lying position, and that at temperatures of 20C or higher, being forced to lie down overlapping another animal would lead to thermoregulatory problems unless forced ventilation and perhaps also misting were used. Hence a space allowance according to the formula $A = 0.0192 W^{0.67} \text{ m}^2$ (where A is space allowance in m² and W is body weight in kg) is appropriate for transport during which no food and water provision occurs. This would provide 0.42m² per 100 kg pig. Careful driving and management which minimises fighting are both important. It is not appropriate to attempt to compensate for bad practice in these respects by increasing stocking density, even on short journeys.

When pigs are to be transported over longer distances, where watering and feeding are necessary, space must also be allowed for all pigs to be able to carry out these activities on the vehicle at one time. A minimum space allowance of 0.60 m² per 100 kg pig is used in practice in The Netherlands and Denmark for such long distance transports of breeding pigs and this is similar to the EU proposal for space allowance to be used for long distance pig transports, where animals are to remain on the vehicle for resting rather than being off-loaded at a staging point. With these space allowances, the animals can get to food and water on the vehicle. The space allowance which provides room for resting, feeding and obtaining water is given by the formula $A = 0.0274W^{0.67}$ m² which provides 0.60 m² per 100 kg pig. With 0.40 m² per 100 kg and higher space allowances, careful driving is essential to ensure that pigs are not thrown about.

Pigs for further fattening: While there is a great deal of evidence on the space requirements of slaughter pigs, research into appropriate values for smaller pigs is relatively sparse. Riches and Guise (1997) and Riches (1998) compared space allowances of 0.15, 0.18 and 0.23 m² per 30 kg pig (equivalent to 0.5, 0.6 and 0.76 m² /100kg) during commercial transports averaging three and a half hours (range two hours to six hours) at moderate temperatures (13-15 C within the vehicle). The space allowances used had no effect on piglet heart rate, salivary cortisol values or on posture. Between 42 and 47% of pigs sat or lay during the journey and pigs did not utilise the available floor space but preferred to huddle. Riches (1998) compared space allowances of 0.064, 0.084 and 0.145 m² per 6-10 kg piglet for transports of one hour in a trailer. Again there was no effect of space allowance on piglet heart rate and the available floor space was not utilised. Only 27-29% of piglets of this size lay down during the transport and there was no effect of space allowance. In both of these studies excessive vehicle movement is likely to have been the reason why some pigs did not lie down. Using 18 to 20 kg live weight pigs with a high space allowance (0.32 m² per animal) Geers *et al.* (1994) reported that pigs lay down for 90 % of the time. Barton Gade (1999, unpublished material) confirmed that small pigs lie down more rapidly during transport than slaughter pigs. At live weights of 7.25 and 30 kg, most pigs were already sitting or lying 20 minutes after the start of the transport. These observations were made in dedicated transport vehicles with air conditioning and in the dark, which may have had an effect on pig behaviour. This work compared two space allowances for 25 and 30 kg piglets and used only one for 7 kg piglets. On the basis of behavioural studies a space allowance of 0.06, 0.15 and 0.17 m² seemed to be an appropriate compromise between ease of movement and support during braking for 7, 25 and 30 kg piglets respectively for transports of about one hour.

As with slaughter pigs, more space must be made available if watering and feeding on the vehicle is necessary. However, there is no reported research into this type of transport in the literature.

Large pigs: As far as can be ascertained, no scientific research has been carried out into the effect of space allowance on the transport of sows and boars. These transports have an added problem in that sow and boar sizes vary far more than is the case for pigs for further fattening or slaughter pigs. There are particular problems if lactating sows are transported.

The equations given above for slaughter pigs are also appropriate for pigs for further fattening and larger pigs.

7.3.2. Deck heights

Pigs need sufficient headroom to ensure adequate ventilation and to maintain normal posture when standing. For large pigs the highest point on the body is the middle of the back. However, the actual amount of headroom necessary will depend on the ventilation within the vehicle, particularly, when this is stationary. All things being equal, forced ventilation systems will allow a lower deck height than natural ventilation.

Barton Gade and Vorup (pers. comm.) showed that the relationship between live weight and average height is curvilinear and could be described by the equation:

$$\text{Height(cm)} = 38.8639 + 0.4272 \text{ Weight(kg)} - 0.0008375 \text{ Weight(kg)}^2; R^2 = 0.95$$

Live weights varied between 26 and 260 kg and the pigs were three and four breed crosses of Large White, Landrace, Duroc and Hampshire and for sows crosses of Landrace and Large White. Maximum heights were about four cm above average heights.

Using this equation, pigs of 25-30 kg live weight have an maximum height of 49-51 cm, pigs of 100 kg live weight 77 cm and the tallest sow (246 kg) had a height of 97 cm. A subsequent sample of breeding boars showed that the maximum height varied between 105 to 115 cm, depending on the breed concerned.

7.3.3. Interactions with other factors

Reported work on the affect of deck heights on pig welfare and meat quality is sparse. Christensen and Barton Gade (1999) showed that varying the lower deck height from 90 to 130 cm had no effect on internal temperatures within the vehicle or on heart rate, when ventilation openings varied between 15 and 35 cm and the vehicle was in motion. Natural ventilation only was used in this work.

In a recent pilot study (Nielsen *et al.*, pers. comm.) the effect of a stop of two hours with a fully laden vehicle at environmental temperatures between 18 and 26 C was investigated. In this work the forced ventilation was operated continously (75 m³/100 kg pig/h and with ventilators at one side of each compartment), when environmental temperatures reached 18 C, and at temperatures above 23 C the misting system was also used for one minute every 20 minutes. The results showed that temperatures inside the vehicle were similar to outside temperatures with a maximum difference of + 5 C, dependant on compartment. On the hottest day (26 C) there was least difference between inside and outside temperatures, possibly as a result of the misting of the pigs. Relative humidity increased slightly during the stop and was slightly higher inside the vehicle relative to outside temperatures but even with misting never reached 80 %. Heart rates were not increased relative to the transport before and after the stop. However, apart from a few agonistic

confrontations the pigs were calmly standing, sitting or lying during the stop with no overt signs of discomfort. In this work a deck height of 90 cm and a space allowance of 0.35 m² per 100 kg pig was used, which would seem to indicate that this height is appropriate, even with a low space allowance, as long as forced ventilation systems are used.

Irrespective of pig height, the deck height should be such that the driver can enter the vehicle to off-load animals (see also Chapter 4, Inspection). Christensen *et al.* (1994) showed that there were problems with off-loading triple-decked vehicles in several European countries if the driver had no facility to raise the decks. In such cases force was often used to off load the pigs with poorer welfare as a result. Thus, with a deck height of 90 cm there must be a facility to raise the decks to allow a considerate treatment at off-loading. If this is not possible and the driver is unwilling to crawl into the vehicle to off-load pigs from the lower deck, then the deck height must be increased.

7.4. Sheep

7.4.1. Introduction

Stocking density during transport is important for several reasons. Very high stocking densities will prevent the animals from lying down (Cockram *et al.*, 1996; Knowles *et al.*, 1998) and this may cause fatigue and muscle damage, particularly during long journeys (Knowles *et al.*, 1998). Also, at too high a stocking density the risk of heat stress increases, because the increased contact between animals will limit their ability to dissipate heat and at the same time will increase heat exchange between individuals (Schrama *et al.*, 1996; Knowles *et al.*, 1998).

7.4.2. Factors affecting the space needed

The amount of space needed by each animal will depend on the following factors:

- (1) **Body weight.** Clearly, the bigger the animal the more space it will need. Therefore, recommended stocking densities should be defined in terms of m²/100 kg rather than m²/animal (Knowles *et al.*, 1998).
- (2) **Presence of wool and thickness of fleece.** These can make a large difference to the amount of space needed and unshorn animals need more space than shorn ones (Knowles *et al.*, 1998). It has been suggested that unshorn sheep with thick fleece need 25% more space than shorn sheep (Grandin, 2000). Others (Loynes, 1983; MAFF, 1983) estimate that shearing the sheep reduces their floor area requirement by 15%, although this refers to housing conditions rather than transport.
- (3) **Presence of horns.** Dickson and Stephenson (1979) suggest that horned sheep need 17% more space, although this refers again to

housing conditions. Other authors dispute that horned sheep need more space (Baxter, 1992).

- (4) **Temperature.** Too high a stocking density may worsen the effects of high ambient temperatures (Schrama *et al.*, 1996; Knowles *et al.*, 1998).
- (5) **Behaviour of animals during transport.** Sheep tend to lie down less than pigs during transport, even if they have sufficient space to do so (Bradshaw *et al.*, 1996a). In particular, sheep do not lie down immediately after the start of a journey, but will do so in increasing numbers over the first four to ten hours (Knowles *et al.*, 1995; Knowles, 1998), provided they have sufficient space (Cockram *et al.*, 1996; Knowles *et al.*, 1998) and the journey is not too rough (Ruiz de la Torre *et al.*, 2001). Therefore, sheep may not need to lie down during short journeys but they do during long ones (Grandin, 2000).

Some animal transporters state that animals are able to maintain their balance more easily when the stocking density is very high. However, this does not seem to be the case. Sheep try to keep balance independently rather than leaning one on another (Buchenauer, 1994). In cattle also, Tarrant *et al.* (1988) found that high stocking densities prevented the animals from maintaining their balance. Cockram *et al.* (1996) found no evidence that low stocking densities resulted in more traumatic injuries. Taken together, these results suggest that sheep need additional space to keep their balance on rough journeys and that increasing their space allowance does not have detrimental effects provided that the driving standard is good.

The height of compartments for sheep will cause them problems if they are unable to stand in a comfortable position. This position involves the head being held up so that the top of the head is the highest point on the animal. Since the space above the back of a sheep is not great if the roof is at head height, high temperature and humidity resulting from poor ventilation can cause severe problems for sheep. The space above the top of the head should therefore be 15 cm for vehicles with good forced ventilation systems and at least 30 cm for vehicles without forced ventilation.

The Farm Animal Welfare Council of the United Kingdom recommended a space allowance equivalent to $0.021 W^{0.67} \text{ m}^2$ (FAWC, 1991), but for animals of the weights studied by Knowles *et al.* (1998), this stocking density is too high and causes fatigue.

It has been recommended that space allowance must be enough for all animals to be able to lie down (Knowles *et al.*, 1998). Nevertheless, the actual allowances proposed to achieve this vary between authors. For example, Cockram *et al.* (1996) suggested that at least $0.77 \text{ m}^2/100 \text{ kg}$ is necessary for 35 kg lambs, whereas Buchenauer (1996) recommends, on the basis of measurements of space occupied, $1.14 \text{ m}^2/100 \text{ kg}$ for 35-40 kg lambs.

From the above data, it is suggested that for journeys longer than four hours, all animals should be able to lie down. This would mean a base line space allowance of $0.8 \text{ m}^2/100 \text{ kg}$. The equation which should be used to calculate space allowances for shorn animals is $A = 0.026 W^{0.67} \text{ m}^2$ (W = body weight

in kg). This gives 0.31 m² for 40 kg lambs, 0.25 m² for 30 kg lambs and 0.19 m² for 20 kg lambs. This figure should be increased if animals are unshorn, temperatures are very high the journey is likely to be very rough. For journeys of less than four hours it is not necessary that all animals are able to lie down so the equation to use for space allowances for shorn sheep is $A = 0.021 W^{0.67} \text{ m}^2$. This gives 0.24 m² for 40 kg lambs, 0.21 m² for 30 kg lambs and 0.16 m² for 20 kg lambs. Also, a deck height which allows the animals to stand with their heads in a normal position is needed.

For journeys lasting more than 12 hours, animals have to be fed and watered on the vehicle. In order for this to be done in such a way that all individuals receive sufficient food and water, an increase in available space is needed. The space allowance which allows this is $A = 0.037 W^{0.67} \text{ m}^2$.

7.5. Cattle

7.5.1. *Range of cattle sizes to be considered*

A major problem with predicting space requirements for groups of adult cattle is the range of weight (at least between 250 to 700kg) that animals may be marketed at. Groups of cattle therefore can be very variable in size. This contrasts with the situation in pigs and sheep where most animals are relatively consistent in size and weight within a group. The total space requirements of a group of cattle that are all of similar size and weight will possibly be different from those of a more variable group. The situation is exacerbated by the relatively small number of adult cattle transported in one pen. So, a pen of sheep might contain 20 to 30 animals, a pen of adult cattle only 4 to 6. This means that defined ranges of acceptable space allowances may need to be somewhat wider for cattle than sheep, purely from the point of view of practicability.

7.5.2. *Floor space allowance for cattle*

When calves or cattle are transported they either remain standing or adopt a position of sternal recumbency. Cattle are more likely to lie down if the surface is comfortable, for example, if there is a layer of straw on the floor. Recent studies (J.Hartung, pers comm) indicate that on motorway journeys with a substantial layer of straw bedding provided, most cattle lay down after a few hours. However, it seems that most adult cattle can stand on a vehicle for 12 hours without ill-effect. Standing and lying require approximately the same floor area although the transition between the states (changes in posture such as getting up or lying down) requires additional space. If cattle fall down during transport they may have trouble standing again Randall (1993) reviewed information available for predicting the floor space requirements of animals and derived two equations. For cattle and calves (and pigs) the relationship was described by the equation:

$$A = 0.01 W^{0.78}$$

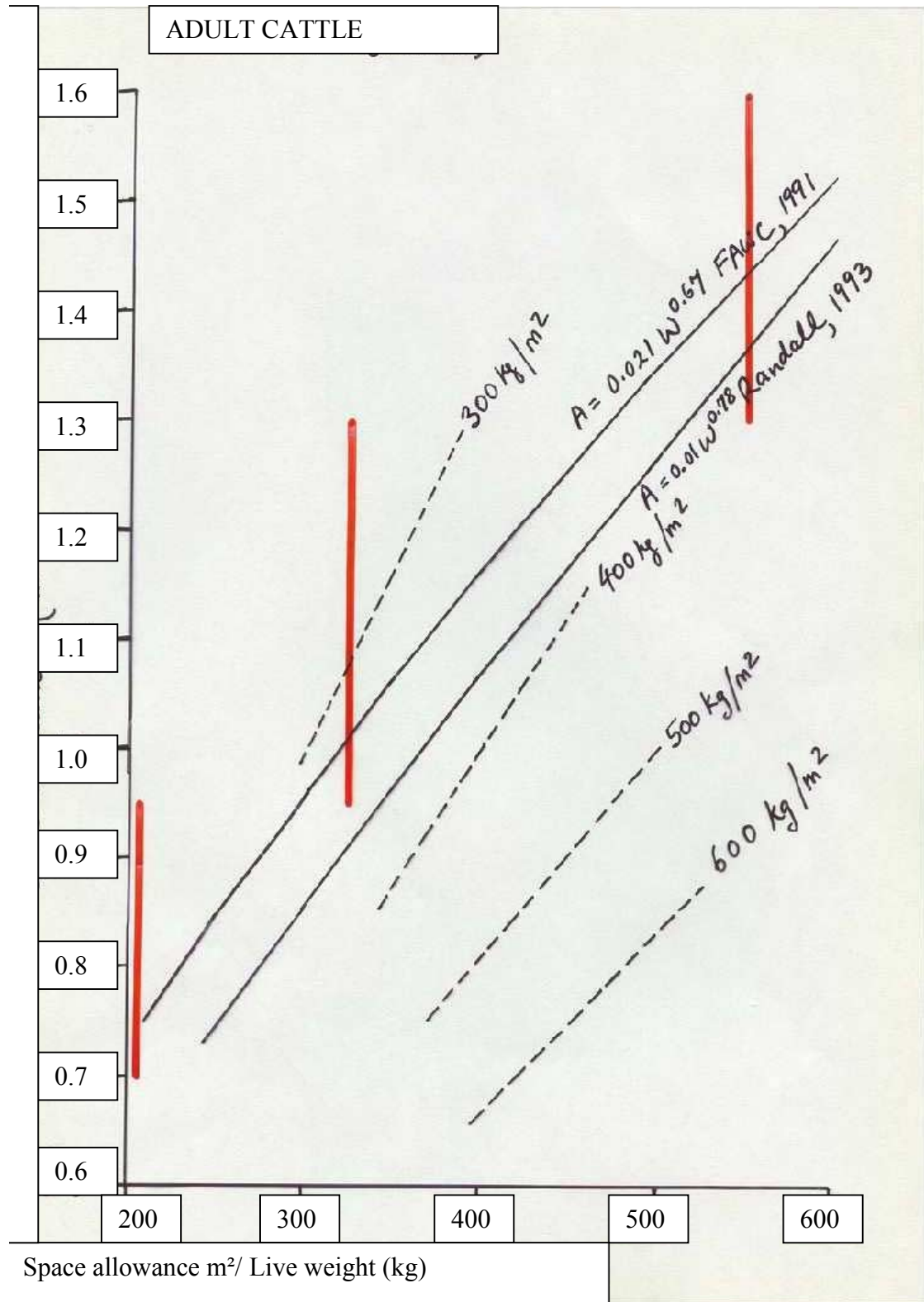
for animals weighing between 20 and 700kg (where A is the required floor area in m², and M is the live weight of the animal in kg). Randall considered the space allowances derived from this equation to be minimum values and, because it gave more generous amounts of space for larger animals,

recommended the use of the FAWC (1991) equation $A = 0.021 W^{0.67} \text{ m}^2$. Moreover, he suggested that the figures derived from these equations would be only suitable for short journeys, which he defined as less than about 5 hours.

The minimum space requirements of any particular animal can be determined from its dimensions. Randall (1993) used information from the American Society of Agricultural Engineers (1987) to derive equations to predict the length, width and height of cattle ranging in weight from 50 to 600kg. Information was available for both beef and dairy (Holstein) breeds. These equations for single animals tend to predict much higher space requirements for an individual animal than the previous equations derived for groups.

Table 2. Space requirements predicted for standing animals of 300, 400 or 500kg by FAWC's (1991) equation, Randall's (1993) equation, and the predicted dimensions of individual animals.

Weight (kgs)	$A=0.01 W^{0.78}$ (m ²) (Randall, 1993)	$A=0.021 W^{0.67}$ (m ²) (FAWC, 1991)	Individual animal
300	0.855	0.959	1.18 (beef) 1.09 (dairy)
400	1.07	1.16	1.45 (beef) 1.27 (dairy)
500	1.27	1.35	1.69 (beef) 1.58 (dairy)



In Figure 1 (Warriss pers. Com. 2002) are plotted the space allowances for cattle ranging in weight from 250kg to 600kg based on the equations of FAWC (1991) and Randall (1993). For reference purposes the lines corresponding to 300, 400, 500 and 600 kg/m² are marked. The three ranges of space allowances (m²) prescribed for road and rail transport in Chapter VI of EU Directive 91/628 (as amended by Directive 95/29) are also marked.

Tarrant *et al.* (1992) studied the losses of balance and falls by cattle transported for 24 hours at low (about 440 kg/ m²) medium (about 505 kg/ m²) and high (about 570 kg/ m²) stocking densities. At low and medium densities braking caused most losses of balance but at high density it was cornering. A high density reduced the number of shifts in position by the animals, but increased the number of struggles and actual falls. Plasma cortisol, plasma CK and carcass bruise score all increased progressively with higher stocking densities. Stocking density can modify the behaviour of cattle even when the vehicle is stationary. When unfamiliar cattle are mixed they show increased aggressive and sexual behaviour. Kenny and Tarrant (1990) found that higher stocking densities in vehicles tended to reduce the levels of some of these behaviours.

There is some evidence (Eldridge and Winfield, 1988, quoted by Tarrant and Grandin, 2000) that a more appropriate density is a medium one (1.16m² per animal of 400kg), compared with a low density (1.39m² per animal) or a high density one (0.89m² per animal), based on bruise scores. The medium density (1.16m² per animal) corresponds exactly with that derived from the FAWC (1991) equation.

There is merit in defining the acceptable floor space requirement for groups of transported cattle using an equation rather than a series of absolute figures corresponding to representative live weights. This could be achieved by using the FAWC (1991) equation ($A = 0.021W^{0.67} \text{ m}^2$) to define the minimum acceptable floor space.

7.5.3. Relationships of stocking density requirements to other factors

Most cattle are transported in such way that they can move around in the vehicle. However, if cattle are tied there is a serious risk of injury if they fall. If it is necessary to tie cattle for a short period during loading, the risk to the animals is prevented by untying them before vehicle movement begins.

If it were required that cattle be fed and watered on the vehicle then they would need more space in order to gain access to the feed and water containers. Some animals may be unwilling to drink when closely confined. In the study of Knowles *et al.* (1999) of cattle transported in groups of five animals per pen at a space allowance of about 0.27 m²/100kg live weight, 42% did not drink when offered water during a 1 hour rest stop. However, Chupin *et al* (2000) found that cattle did drink in a similar circumstance.

In order to provide sufficient space for each animal in a group of cattle to rest, feed and drink on a vehicle, the space required is given by the formula $A = 0.0315 W^{0.67} \text{ m}^2$. This is 50% greater than the space for just standing. Care during driving is important with this greater space allowance so that braking and lateral accelerations do not cause animals to fall.

7.5.4. Horned cattle

Cattle with horns may require more space than polled animals. The Livestock Conservation Institute (USA) recommends floor space allowances be

increased by about 5 to 7% for horned animals. Bruising is reduced if horned cattle have 10% more space (T.Grandin pers comm).

7.5.5. Calves

Calves can range in weight from about 50kg at one to two weeks of age through about 100kg at 3 months of age to over 300kg at 6 months. At 6 months old they would probably be equivalent to adult cattle in terms of transport requirements. Kent and Ewbank (1983, 1986^a, 1986^b) examined the transport of calves of different ages. Very young calves 1 to 3 weeks old spent on average a third of the journey, whether this was 5-6 hours or 18 hours, lying down. At 3 months old they spent 14% of a 6 hour journey, and 42% of an 18 hour journey, lying down. At 6 months only 6% of the journey was spent lying. The implication is that smaller calves, perhaps up to at least 3 months old, prefer to lie down for at least a substantial part of the journey. They therefore need enough space to do this comfortably. The spaces required to lie down given by the FAWC (1991) equation is given in Table 3.

Table 3. Space requirements (m²) for calves predicted from the FAWC (1991) equation

Live weight (kg)	FAWC (1991)
50	0.288
55	0.307
100	0.459
110	0.489
150	0.602
200	0.730

The EU Directive prescribes space allowances of 0.30 to 0.40m² for 55 kg calves and 0.40 to 0.70m² for 110kg calves. These seem to agree with the FAWC (1991) predictions in Table 3 and probably provide sufficient space for the animals to rest effectively. However, in two studies of the transport of calves that were less than 1 month old, Knowles *et al.* (1997, 1999) used stocking densities that allowed a space equivalent to between 0.39 and 0.45 m² per calf of about 55kg live weight. This was certainly enough to allow all animals to lie down.

7.6. Conclusions

Transported animals require a certain floor space allowance in order to stand comfortably and keep their balance during vehicle movement. They require a larger space allowance to lie down and it is likely with a group of farm animals that there will be occasions when they all need to lie down at the

same time for example after any 8-12 hour period of vehicle movement. A yet higher space allowance is required for animals which have to walk around within the vehicle in order to obtain food or water whilst others may be lying down.

All farm animals which are standing during vehicle movement attempt to stand in such a way that they maintain balance without any contact with other animals or with the vehicle walls. If the vehicle is driven properly they can and do avoid such contact. Avoidance of contact with other animals is also important if overheating is a potential problem. During rest periods, especially when temperatures are low or when the animals are disturbed and require social reassurance, pigs may lie and sheep may stand in physical contact with one another.

The floor space area which allows good welfare on transport vehicles will vary with the species, age, body weight, pregnant or non-pregnant state, presence or absence of fleece in sheep and presence or absence of horns in some cattle. The space can be quoted per unit weight of animal on different scales for different animals. The relationship between body weight and required floor area is not linear because the animal's weight is proportional to its volume. Hence the formulae which relate body weight to required floor area have an exponential component.

The height of compartments within which animals are transported is important in relation to the welfare of the animals in that the animal which is standing needs to adopt a comfortable posture unimpeded. Also it is necessary for adequate temperature regulation and removal of noxious gases that the height of the compartment is adequate for effective ventilation to occur.

Horses almost always stand during transport, even on smooth journeys. They may stand or lie down when resting. Horses require a significant duration of sleep, that is largely achieved at night and in a standing position. Transport may disrupt sleep patterns.

Stabled horses drink about 36 litres each day. In most situations horses drink several times a day, more often in hot conditions. Food and water requirements will be greater during transport than in stables because of the energy needed for balance and higher metabolic rates.

A greater height is needed if no forced ventilation system is provided in the vehicle and the height required for ventilation above the highest point on the animal will vary according to the shape of the standing animal. Horses are susceptible to a range of problems during group transport situations. They do not adapt well physiologically to transport and they can easily injure one another when transported in groups. When horses fall during transport, they often have difficulty standing again if they are in a group. Most horses are transported in vehicles with individual places for each horse and appropriately designed partitions between these. Welfare problems are much less common in such transport conditions than when horses are grouped in pens on a vehicle.

Horses vary greatly in body size. The length and width of widely used stalls on vehicles can be inappropriate for the smallest or largest horses. The design

of partitions is important in that if the space below partitions is too great horses can fall and be trapped under the partition and if the top of the partition is too low the bodies of the horses may not be adequately separated. Partitions which are well designed for the size of horse contribute to a good travelling environment.

Many horses have a preference for facing backwards in a trailer during road transport to maintain better balance.

Horses which are tied during transport, or limited in their movements by chest bars, or which are unable to lower their heads to shoulder height may become trapped or have breathing difficulties. Restraint of horses with their heads in an elevated position (cross-tying) during long journeys can contribute to the pathogenesis of the lower respiratory tract. Tying of cattle also causes problems because if the tie is too short, the animal will not be able to lie down and may be unable to stand up if it falls. If the tie is long enough to allow lying, the animal may step over the tie or otherwise become entangled in it. Welfare can be very poor in any of these circumstances.

At very high stocking densities, pigs forced to stand during journeys have elevated creatine kinase activity in blood, a higher incidence of skin damage, more frequent rectal prolapses and much disturbance because of difficulty in obtaining space for standing.

Where vehicle movement, caused by swerving around corners and sudden braking and accelerating, is not too great, pigs of all ages which have been studied will lie down throughout road journeys. This is probably due in part to the fact that many pigs have some degree of leg disorder or are relatively heavy for their leg strength. The space required for pigs to lie simultaneously is 0.42 m² per 100 kg pig. At 0.35 m² per 100 kg if all try to lie down at the same time they have to lie on the sternum and their bodies overlap, or more often, some are unable to lie down. This stocking density causes problems. The problems are worse at temperatures of 20 C or over, where thermoregulation requires more separation unless forced ventilation and misting are used. Where watering and feeding on a vehicle are necessary, the space required by the pigs is 0.6 m² per 100 kg pig.

The highest point on the body of young pigs is the top of the head but for older animals it is the centre of the back. The height of compartments for pigs needs to be calculated in relation to height above the highest part of the body. For 100 kg pigs ventilation can be adequate at a compartment height of 100 cm or even less but adequate inspection and access, for caring for weak animals, is not possible at this height.

Sheep travelling on journeys with little lateral movement or sudden acceleration will often remain standing for several hours but begin to lie down after 4 hours. When journeys are rough, for example when roads include many bends and vehicles are driven at a speed which is normal for human passengers, sheep will stand but will avoid contact with other individuals, thus requiring more space. Their plasma cortisol levels will be much higher than those of sheep driven on straight roads or kept in stationary, well-ventilated vehicles.

The space needed by sheep during transport depends on body weight, presence or absence of wool and ambient temperature. Sheep need additional space to keep their balance on rough journeys. The space required by shorn sheep of 40 kg to stand on a vehicle is 0.24 m². For 40 kg sheep without a fleece to lie down, 0.31 m² is needed. For fleeced sheep 20% more space is needed. A shorn sheep is one in which the maximum distance from the skin to the outside of the uncompressed wool is 1.5 cm.

Cattle normally remain standing during transport of up to 20 hours duration, even if the vehicle is driven carefully. However, recent studies in which much bedding is used and journeys are on motorways, indicate that many cattle may lie down after a few hours. If cattle fall during transport, they may have difficulty in standing up again. Young calves of up to three weeks of age lie down for a substantial part of every journey and three month-old calves lie down for a smaller part of each journey.

Cattle transported for 24 h had higher plasma cortisol, creatine kinase and carcass bruising, more losses of balance and more falls at a higher stocking density of 570 kg m⁻² than at 505 kg m⁻² or 440 kg m⁻². A density of 1.16 m² per animal caused few problems for 400 kg cattle. This figure conforms with the equation $A = 0.021 W^{0.67}$ (where A is area per animal in m² and W is weight of animal in kg).

The minimum space allowance for cattle to be able to lie down on a vehicle and have adequate access to food and water supply points is 50% greater than that required for standing or sternal lying.

8. JOURNEY MANAGEMENT

8.1. General introduction

The Federation of Veterinarians of Europe has stated (FVE Position Paper 2001) that it has “always been of the opinion that the fattening of animal should take place within or near the place of birth. Animals should be slaughtered as near the point of production as possible. The journey time for slaughter animals should never exceed the physiological needs of the animal for food, water or rest. The long distance transport of animals for slaughter should be replaced, as much as possible, by a carcass only trade. In addition, the transport of animals for breeding purposes can sometimes be replaced by the transport of sperm and embryos.” In this document, the FVE also provides clear guidance on what is required in a route plan and what sorts of checks are required.

Animals going from farm to slaughter may pass through a market. Based on data from the Meat and Livestock Commission, Murray *et al.* (2000) reported that, in the United Kingdom in 1996 56% of cattle, 65% of sheep and 5% of pigs passed through a livestock auction market. In a study of 16,000 sheep travelling to slaughter in south west England, the median journey duration was 1.1 hours, with very few journeys of more than 5 hours, when the sheep went directly from farm to abattoir but 7.8 hours, with over a third of journeys 10-17 hours, when they went via a livestock market (Murray *et al.* loc.cit.)

Journey management comprises all organisational aspects of transport which may affect the animal's welfare, including its health, and which can be influenced by man, such as route planning, design of the vehicle, travel times, driving quality, food and water supply and resting periods. Animals are sometimes brought together at collection points before travel. This has the potential for spreading disease if contact between animals which will not be transported together occurs. There is also a potential for poor welfare if conditions at collection points are not as good as those on farms.

During transport, animals will gradually relax and recover from the stress of loading. Heart rates decrease, cortisol levels fall as the journey progresses (Bradshaw *et al.* 1996a; Broom *et al.*, 1996; Christensen and Barton Gade, 1996; Hartung *et al.*, 2000). However, in pigs and some other species, the levels in home pen conditions are not normally reached. Certain maximum journey duration limits must be fixed, when animals must be offered rest and watering and feeding during longer journeys.

Animals must be adequately prepared for the journey in question and this preparation will depend on the species and the length of the journey envisaged. For shorter journeys preparation can include fasting before collection and possibly movement away from the main herd to protect its health status. Water should be available during holding times of 30 minutes or more. For longer journeys, where watering and feeding will be necessary on the vehicle, it can be an advantage to collect the animals involved two to three days before the transport, so that they can be prepared for the journey and become accustomed to the feed that will be offered on route. If this system is not used, the feed offered during transport should be the same as that to which the animals have been accustomed.

Animal comfort during transport is highly dependent on vehicle design, driving technique and the roads being traversed. Minimum requirements for vehicles will therefore depend on the length of the journey, as established in Directive 95/29/EC. All things being equal, the minimum demands for transport vehicles will become more stringent as transport distances increase and weather conditions become more extreme, whether this is very cold or very hot. Drivers should always be conversant with the needs of animals during transport and must have received formal training, unless previous experience can be proven for the type of transport envisaged.

During transports, where animals are to be watered and/or fed on the vehicle, off- and on-loading during the journey for resting is not recommended. On and off-loading will increase stress levels and the risk of injury. Moreover, there will be a risk of spreading disease. When entire males are being transported, fighting and mounting activity will occur during the resting period unless the animals are familiar with one another. The transport vehicle used for this type of transport must therefore be of such a standard that animals can remain on the vehicle during the resting, watering or feeding period.

On these longer transports it would be a decided advantage if stops for inspection, watering and feeding were co-ordinated with the relevant legislation for drivers. Controlling that inspection etc has occurred is often

difficult and it is more likely that legislation will be observed if it is convenient for the driver.

If at all possible, mixing of unfamiliar animals should be avoided on the transport vehicle, as this will increase aggression and physical damage to animals, particularly when entire males are to be transported (Barton Gade, unpublished material; Bradshaw *et al.*, 1996b; Warriss, 1996). If mixing cannot be avoided, then this must first take place at loading and the groups so formed not further mixed during the journey.

8.2. Horses

8.2.1. Vehicle design

Vehicle design for horse transportation has been reviewed by Houpt and Lieb (1993).

Vehicles, usually called vans, are motorised trucks where the bed is enclosed and fitted with individual stalls to accommodate two or more horses. Trailers (also called boxes or floats) are beds made to be separable from the motorized portion that are enclosed and may or may not be fitted with individual stalls that are called stock trailers. Trailers which connect over the pulling vehicle's rear axles (gooseneck and tractor-trailer) are more stable for towing than trailers connected to the rear (bumper pull or tag along). Space and engineered weight restrictions (axle carrying weight, etc.) determine the number of horses that may be carried, and may range from one to over ten animals for individual stall vehicles and trailers. Large stock type trailers may carry more. Other important factors to be considered include adequate ventilation, light and temperature.

If the horse in one stall can see other horses nearby this facilitates ease of loading and calm behaviour. Rear facing (opposite to the direction of travel) transport stalls result in horses maintaining balance better and showing less muscle fatigue (Clark *et al.*, 1988; Cregier, 1982).

Most transport stalls have head ties and chest bars that require the horse to maintain its head at 25 cm or more above the shoulder. Feed, including hay, is accessed more easily if maintained at shoulder level or below.

Floors need special consideration in both construction and maintenance. Wooden boards of 5 cm by 15 cm size or larger are usually used in smaller trailers, but heavy metal can be used. Rubber mats or bedding prevent slipping on most floors once they get wet. Bedding also encourages the horse to eliminate waste during long transits, which is desirable.

In transport stalls, safe and easy access to the horse's head is needed for tying and care purposes. Shipping crates for air and sea transport may additionally require access to the horse's rearquarters, since it would not be possible to remove the horse in an emergency.

Responses of horses to trailer design, duration and floor area during commercial transportation to slaughter with distances ranging from 596 to 2,496 km were studied (Stull 1999). A mean weight loss of 4%, a greater

percentage of injured horses following transport in straight-deck trailers, muscle fatigue and dehydration, especially in journeys of over 27 h, were recorded. However, most physiological responses to transportation were smaller in horses provided with the greater floor area.

8.2.2. *Preparation for transport*

If the health status of horses is checked prior to and on the day of transport with special reference to the identification of sub-clinical respiratory disease, this can help to identify horses that would be more likely to succumb to shipping fever. Appropriate therapy can then be initiated and the response to this therapy can be identified prior to departure. However, medication such as the administration of so-called prophylactic antimicrobial therapy without evidence of respiratory disease, and the unjustified use of sedatives, is unnecessary.

8.2.3. *Driving quality*

Although during road transportation, horses experience vibrations and oscillations, little published research has defined the magnitude and frequencies to which a horse is subjected and their effects. The Japan Racing Association has conducted studies, reported by Jones (1999), in which accelerometers were positioned to measure and analyse the magnitudes and frequencies of oscillation in 18-horse road transport vans over a period of 16 h. They showed very large differences between public roads and expressways: the frequency of maximum oscillations was lower for expressways than for public roads, indicating there were fewer maximum oscillations or movements during transportation on expressways. Heart rate and accelerations were significantly and positively correlated, and respiratory rates increased, during the course of transport (Hobo *et al.*, 1995).

Smith *et al.*, (1996b) evaluated differences in vibration in a two-horse trailer by evaluating the root mean square accelerations produced in the z-axis in the suspension and the trailer frame, and the hooves and the thoraxes of horses being transported. They found that the natural frequencies of oscillations of the trailer were near those of the horses' bodies, a situation that results in fatigue in humans. Additionally they found that slower speeds and smoother roads produced less vibration and the modification of the trailer's suspension and tyres significantly affected the vibration transmitted to the horse. However, in a related study they reported that changing the trailer suspension to provide different vibration characteristics did not affect heart rates, serum cortisol concentrations nor pulmonary clearance rates of $^{99m}\text{Tc-DTPA}$ in 24-h transport experiments (Smith *et al.*, 1996a).

Transportation for six hours in a stock trailer in the relatively congested traffic conditions (main highways and city streets) of the northeast United States caused a significant stress response in adult horses with previous experience in trailering. Transport resulted in elevated mean heart rates and increased plasma cortisol in transported horses. This, in turn, apparently resulted in suppressed cell mediated, but non-humoral, immune function. However, there was no difference in IL-2 production (Dimock and Ralston, 1999).

8.2.4. *Travel times*

The effects of transport stress have been largely documented by considering behavioural, functional, endocrine and biochemical variables, as well as the effect on the immune system and the onset of pathological conditions, mainly affecting the respiratory system. Besides handling and confinement, the duration of transport seems to greatly modify the stress response, although age, breed and experience of horses appear to also influence it. The effects of transportation have also been studied with regard to performance and reproduction.

Initial handling of some horses does not seem to cause hypercortisolemia. On the contrary, a moderate decrease of cortisol before transport in experienced horses showed the importance of training (Fazio *et al.*, 1995). Confinement on the vehicle has been shown to cause significant increase of β -endorphin and ACTH concentrations (Wi and Chen, 1987), but only after transport of less than 50 km (Fazio *et al.*, 1996). Several investigators have demonstrated increases in plasma cortisol after road transport in horses (Petazzi *et al.*, 1983; Senniksen and Jorgenssen, 1988; Ferlazzo *et al.*, 1993a). Conversely, Linden *et al.* (1991) showed only slight mean changes after transport, but the small number of animals in the (n=5) yielded wide inter-individual variation which the investigators interpreted as indicative of "transport-induced stress being highly influenced by individual psychological factors".

Post- transport increase of β -endorphin, ACTH and cortisol levels of horses are higher during the initial period of transportation than during the following period. A greater degree of stress was recorded in young inexperienced horses than in old ones; however, young horses seemed to be better adapted to long transport (Alberghina *et al.*, 2000). Transportation of acclimatised adult horses for 1 hour in a trailer did not result in any change in β -endorphin levels (McCarthy *et al.*, 1990).

Cortisol increases as a result of transport (Ferlazzo *et al.* 1993a; Fazio *et al.* 1995; 1996) especially in Arabian and Anglo-Arabian crosses (Ferlazzo *et al.*, 1993a). A concomitant increase in plasma triiodothyronine concentrations has also been reported (Fazio *et al.* 1995). Again a significant effect of breed and age on iodothyronine changes after road transport of different length was recorded (Aronica *et al.*, 2000).

In a study comparing the effects of road transport ranging from < 50 to 300 km, the levels of noradrenaline β -endorphin, ACTH, T_3 and fT_3 were increased in horses after short journeys (< 50 km), while those of T_4 and fT_4 were increased in horses after journeys of 150 - 300 km (Ferlazzo *et al.* 1997). Plasma concentration of myocardial depressant factor (MDF) peptide fraction was significantly lowered by road transport in journeys exceeding 100 km (Vinci *et al.* 1994). Mean heart rates are usually elevated during 25 min of road transport and abnormal body positions have also been documented (Waran, 1993; Waran and Cuddeford, 1995).

Increases in the activities of serum CK, AST, and LDH have also been described as result of long journeys of unspecified length (Petazzi and Ceci, 1981; Codazza *et al.*, 1991) and on short journeys of 70 minutes and 50 km

duration (von Schmidt, 1980). It has been reported that road transportation of Sanfratellani horses over distances of 130 to 200 km resulted in significant elevations in serum creatinine and creatinine kinase (CK) (Caola *et al.*, 1984). Similar changes were recorded after journeys of 130 to 350 km in 16 untrained horses of various breeds in aspartate amino transferase (AST), lactate dehydrogenase (LDH), alanine aminotransferase (AAT), and serum alkaline phosphatase (SAP) (Ferlazzo *et al.*, 1984). Changes in AST, LDH, and creatinine have also been recorded in asses (Ferlazzo *et al.*, 1983), but changes in the activities of serum enzymes were not evident in ponies transported by road (Abbott, 1979).

Significant decreases in the concentrations of the free amino acids methionine, taurine, and 3-methylhistidine after road transport have been recorded (Omero *et al.*, 1982) and although blood lactate and pyruvate increases may be seen the lactate/pyruvate ratio may decrease (Ferlazzo *et al.*, 1982).

Beaunoyer and Chapman (1987) studied trailering stress on subsequent submaximal exercise performance in mature Quarterhorses. Of the blood metabolites, sodium, potassium, chloride, glucose and total protein, only the serum potassium concentration showed a treatment effect and the authors believed that this might be due to potassium shifts between intracellular and extracellular fluid compartments, rather than a net gain or loss of potassium. Their data suggested that transportation of the horse for approximately one hour just before a submaximal exercise event should not affect its physical performance. Studies of a group of show-jumping performance horses compared various parameters during performances at a show away from home with those of similar performances at home. While the transportation stress was not separated from the stress at the show away from home, Russoniello *et al.* (1991) found that lymphocyte proliferative response was not adversely affected by acute show-jumping performance and was accompanied by the expected haematological responses of increased blood counts and erythrocyte sedimentation rate values.

Transport in trailers has been found to have relatively little effect on performance, as measured in time trials in eight quarter and Thoroughbred horses transported for 8.1 km during 15 minutes or for 194 km over a 2- to 2.5-hour time period).

Road transport of different length (10-100 km) before show jumping competition only affected basal and post-exercise fT_3 levels (Cusumano *et al.*, 2001).

The effects of air transport are extremely difficult to quantify. However, it has been noted that racehorses that are transported long distances by air tend to have minor elevations in CK and AST on arrival. Those racehorses which have been successful in their target race on arrival after long-distance air transport have tended to lose less body weight (up to 10 kg) in transit than those which have raced badly (more than 20 kg) (Leadon, 1994).

Effects of transportation on reproduction have been studied in some studies. Baucus *et al.*, (1990a) found that transportation of mares for 792 km (12

hours) during the preovulatory stage of oestrus did not alter oestrus behaviour, ovulation, duration of the oestrus cycle, pregnancy rates or pre-ovulatory surges of oestradiol and LH despite increased levels of serum cortisol and plasma ascorbic acid indicative of stress. Baucus *et al.* (1990b) reported no effect on the incidence of early embryonic death in pregnant mares of a 472 km (9 hours) trailer trip taken either at 16-22 days or 32-38 days of gestation. Fifteen mares were used per treatment and compared to 24 control mares; the trailered mares had hormonal and plasma ascorbic acid changes indicative of acute stress.

Prolonged transport stress induced changes in haematology (stress neutrophilia) and serum biochemistry have also been demonstrated to occur during air transport of 112 horses from London (England) to Sidney (Australia) (Leadon *et al.*, 1990). During the flight, there were no differences in these variables between normal horses and those which eventually became ill upon arrival (n=7). However, after arrival, ill horses had further increase in peripheral white blood cell counts, neutrophil counts, and serum globulin and fibrinogen concentrations compared to their healthy counterparts. These additional haematological changes were thus reflective of the development of respiratory illness but the initial changes were not valid predictors for which horses would become ill since all horses manifested some initial changes. Similar stress neutrophilia was documented after road transportation of 337 Thoroughbred horses in Japan (Yamauchi *et al.*, 1993).

However, 7 adult 3-day-event horses did not demonstrate elevations beyond the normal range in plasma cortisol and free fatty acids when transported over a distance of 2000 km in a 24-hour period (Senniksen and Jorgensen, 1988).

It is well known that an increased incidence of equine respiratory disease follows prolonged transport. Pre-existing mild respiratory infections may develop into pneumonia when horses are transported (Raphael and Beech, 1982). Exposure to increased noxious gases or large amounts of airborne irritants in the vehicle and increase of endotoxin concentrations may contribute to the development of the disease (Chrisman, 1987; Leadon *et al.*, 1990; Hobo *et al.*, 1995, 1999). Additionally, pulmonary defence mechanisms may be adversely affected by transit-associated stress (Bayly *et al.* 1986; Chrisman 1987). Superoxide-scavenging ability decreased significantly at 23 h and 40 h after the start of road transport; it is assumed that superoxide influences the development of airways inflammation during transport when respiratory rates increase (Ishida *et al.*, 1999).

Predisposition to respiratory disease after transport may be due to a marked increase in the numbers and, in viral-infected horses, the activity of pulmonary alveolar macrophages. Depression of cellular immunity may be related to increased cortisol levels. However, road transport of seven healthy Thoroughbred horses over 1160 km for 36 hours did not affect selected pulmonary alveolar macrophage functions (Chrisman *et al.*, 1992).

Transport has been shown to also have adverse effects on the immune system. Anderson *et al.* (1985) examined 9 horses with viral infections (primary equine influenza) after recent transport. These subjects were compared with three horses with no history of transport stress. Affected horses' pulmonary

macrophage numbers and activity were decreased compared with controls. Bayly *et al.* (1987) reported, after road transport of 1930 km, a significant decrease in numbers of pulmonary macrophages, neutrophils, and lymphocytes recovered from bronchoalveolar lavage (BAL) fluid. These effects peaked in severity one week after shipment and remained measurable for four weeks. Chrisman *et al.* (1992) shipped seven Thoroughbred horses 1050 km and demonstrated transiently decreased pulmonary macrophage numbers (1 week later), viability (week 2) and killing activity (week 2). Traub-Dargatz *et al.* (1988) shipped eight horses for 12 h and examined the effects on the horses' BAL fluid cell numbers. While their BAL technique apparently resulted in increased cell numbers even in their control (non-transported horses), there was a delay in the development of this increased cell number for several days after transport. They concluded that transport stress decreased their subjects' ability to respond, with increased inflammatory cell numbers, to the recurrent BAL. Macrophage function was not measurably affected in transported horses compared with controls.

Therefore, it is evident that transits of 8-12 hours or more tend to be more measurably stressful and consideration should be given to monitoring welfare and pathology indicators.

It has been shown that an increased incidence of disease occurs with increased transport distance or travelling time and that restricting travel time to less than 12 hours should greatly reduce the probability of a horse experiencing transported-related pyrexia or respiratory disease (Oikawa and Kusunose, 1995).

8.2.5. *Feeding and watering*

In a stable environment, the feeding behaviour of horses is influenced by their diet. If fed exclusively on hay, they spend 40% of their day eating. If fed chiefly on concentrates they spend one-tenth of that time eating.

Drinking is stimulated when extracellular body fluid is diminished. As a rule, horses do not drink very frequently in a 24-h period and many may only drink once or twice a day. When they drink, they usually consume very large quantities of water, totalling about 20 swallows. Stabled horses spend about 3 hours eating and a total time of 15 min drinking about 36 litres each day.

There are few data available concerning feeding and watering practices during transport. However, water and feed intakes during transit and after arrival in a new environment are very critical to maintenance of normal body functions and has long been recognised as a problem in individual racehorses. It was clearly demonstrated that during transit horses spend less time in feeding (Waran and Cuddeford, 1995)

Most owners provide their horses with hay to eat during transit. It can be useful to avoid feeding grain during travel because the risk of colic due to gut stasis. It is the usual practice of the horse transport industry to provide horses with a light laxative diet, e.g. a series of bran mashes, prior to medium- or long-haul journeys.

It is difficult to provide water continuously, so frequent stops may be necessary. Many horses will not drink water from unfamiliar sources but will drink water brought from home during stops on a journey.

Hay should be provided on an *ad libitum* basis throughout the journey, and water should be offered every 6 to 8 hours.

Mars *et al.* (1992) studying pregnant mares found that water intake was reduced by more than one-half the first day after a 4-hours transport, even in the group which were receiving familiar water. Water intake returned to normal by the second day. Novel water was more readily accepted when offered in familiar surroundings rather than new surroundings. The plasma osmolality showed that dehydration immediately post-transit was within the normal range although the heart rates were significantly higher in-transit and post-transit than pre-transit. The mares showed a preference for apple rather than clover flavouring in the water.

During air transport, water should be offered every 2-4 hours during transit if environmental temperatures are high and blankets may be needed to prevent chill during low temperatures. Horses are usually offered hay *ad libitum* while the aeroplane is in flight, and water is usually offered every 6 to 8 hours or at landing stops.

Water and electrolyte intake and output in Thoroughbred horses with experience of transport, when transported by road in relatively hot environmental conditions were measured: it was recorded that although water was always available, horses failed to drink during transit, but the feed intake was unaffected during travelling although it decreased for 6 h following transportation. It was concluded that transportation by road affected the water and electrolyte balance of conditioned horses for a period up to 6 hours after travelling (van den Berg *et al.*, 1998).

Tame horses in good conditions and initially deprived access to water for approximately 6 hours can be transported in groups in open trailers during hot, humid conditions for up to 24 hours before dehydration and fatigue become severe. Rectal temperature and appearance of the horses were the most useful measures for determining crisis situations (Friend *et al.*, 1998).

Restriction of food and water during transportation can produce a weight of loss which is evident even after a couple of hours and can persist for more than 24 h (Foss and Lindner, 1996).

A study aiming to characterise progressively dehydration, stress responses, and water consumption patterns of horses transported long distances in hot weather and to estimate recovery time after 30 hours of commercial transport was done: it was concluded that transporting healthy horses for more than 24 hours during hot weather and without water will cause severe dehydration; transport for more than 28 h even with periodic access to water will likely be harmful due to increasing fatigue (Friend, 2000).

8.2.6. *Rest periods*

Adult horses do not lie for very long periods and they rest in various ways. A common form is a state of drowsiness, while standing or lying.

Horses are polyphasic animals as regards sleep and rest periods: 95% of horses have two or more such periods per day. During the day the horse is awake and alert over 80% of the time. At night the horse is awake 60% of the time but drowns for 20% of the time in separate periods. Many horses accumulate 6-7 hours of rest during each 24-hour period.

Even in a conscious state, some degree of rest can be acquired by horses in static postures for periods of time. Resting stances and resting recumbent positions are frequently adopted by horses throughout each day. The total time spent recumbent per day is approximately 2.5 hours, with time variations associated with age and management. Ponies are recumbent for 5 hours per day.

Sleep is largely achieved in standing position. However, in circumstances like transportation sleep patterns can be disrupted. Interruption of activity cycles and loss of sleep may in fact play an important role in the aetiology of the stress-related diseases associated with livestock transport and novelty.

There are no data concerning the frequency or duration of rest stops for long distance travel but it appears horses need to relax preferably overnight for every 6-10 hours of transit.

8.3. **Pigs**

8.3.1. *Vehicle design*

Pig comfort during transport is highly dependent on vehicle design and driving method as well as the quality of road being traversed. Pigs being monogastric animals can suffer from travel sickness particularly if they have been fed close to collection and the vehicle suspension is inappropriate (Randall and Bradshaw, 1998).

Vibration characteristics: The vibration characteristics of transport vehicles affect pig comfort, particularly travel sickness in pigs (Randall *et al.*, 1996). This work was part of an EU funded project on methods of improving pig welfare and meat quality by reducing stress and discomfort before slaughter (EC-AIR3-Project CT92-0262). It showed that vibration characteristics were affected by the type of suspension on the vehicle, whether it was being driven over good or minor roads, the speed of the vehicle and finally, on whether it was fully laden or partly empty. The best vehicle, a two-decked vehicle with air suspension on all axles, provided a very smooth ride even when partly empty, whereas a small towed twin axle trailer, such as those used by farmers for transporting small numbers of pigs gave a very uncomfortable ride. A conclusion from this project was that vehicles for transporting pigs should have a suspension system with the same characteristics as full air suspension i.e., air suspension on all axles.

Insulation: Pig comfort is also affected by the internal surfaces to which they are exposed. Not only should these be designed so that there are no protruding parts that can damage animals but the floor, walls and also the roof should be insulated, so that pigs are not exposed to hot surfaces in summer and cold surfaces in winter.

When pigs of less than four weeks of age are transported in cold conditions, they may need supplementary heat sources as well as an insulated floor because their thermoregulatory ability is much less good than that of older pigs. However, except in emergency situations, it is undesirable for such young pigs to be transported.

Ventilation: When vehicles are in motion, ventilation is not compromised, provided that ventilation openings are sufficiently large and traverse the whole length of the vehicle at pig height. Ventilation openings of 150 and 350 mm with varying deck heights on the lower deck (900 to 1300 mm) had no significant effect on internal temperatures in the vehicle or on heart rate in pigs, when the vehicle was in motion (Christensen and Barton Gade, 1999).

However, when the vehicle is stationary, some form of forced ventilation, whose power source is independent of the vehicle's, should be used, especially when deck heights are low (see section 6.3.2). Unfortunately, there is no reported work on the optimal positioning of ventilators or their capacity for stationary vehicles. However, routine transports with the vehicle used by Christensen and Barton Gade, (1999) used forced ventilation (capacity corresponding to 75m³ per pig, 120 pigs in all) during loading pigs and continuously during transport, when environmental temperatures reached about 20C, as well as an intermittent misting system, when temperatures reached 25C, led to a low transport mortality (0.012 %) over a 27 month period.

Inadequate ventilation in transport vehicles has a clear effect on transport mortality. Nielsen (1981) showed that mechanical ventilation in single decked transport vehicles reduced transport mortality by almost 50 % (from 0.046 % to 0.024 %). In the above mentioned routine transports (Christensen and Barton Gade, 1999) transport mortality was 0.012 % but all pigs that died were in the front compartment on the lower deck, where the temperature within the vehicle was highest and by implication the ventilation was poorest. A similar result was found by Sains (1980) and Riches *et al.* (1996).

Misting (sprinkling) systems: Wetting pigs at intervals during transports in hot weather is used in several European countries to cool pigs during transport (Christensen and Barton Gade, 1999, Warriss, 1998). There is, however, no research to show the effects of misting or its optimal usage.

Flooring: Flooring should be non-slip and preferably of a material that reduces noise during loading and off-loading. Profiled metal flooring is non-slip, when not worn, but the noise from pig's feet on loading and off-loading can make pig movement into and out of the vehicle more difficult.

Compartment sizes: Other research (Barton Gade *et al.* 1992) has shown that it is easier to move groups of pigs where it is always possible to reach the foremost animals that are causing a blockage. A practical figure for the

number of slaughter pigs in a group has been found to be 15. For smaller pigs, however, much larger groups have been found to be appropriate (Barton Gade, 1999).

8.3.2. *Animal preparation*

The interaction between farm personnel and pigs during the fattening period affects both production factors and pig well-being (Hemsworth and Barnett, 1991 and Hemsworth *et al.*, 1989). Negative treatment by humans during the fattening period increased their level of fear and will lead to an animal that is more difficult to handle. Grandin *et al.* (1986, 1987) showed that positive interaction with pigs (quiet petting in the pen for 10 mins. per week) reduced excitability and the force necessary to move a pig through a race. Farm personnel that interact positively with pigs, even though this interaction is of relatively short duration, can therefore be expected to lead to animals that are less excitable and easier to handle.

Pigs should be fasted for some time before collection irrespective of the length of the journey envisaged, as they can suffer from travel sickness, particularly if vehicle suspension is inappropriate, driving technique is poor and the roads traversed bad (Bradshaw *et al.*, 1996; Randall *et al.*, 1996; Randall and Bradshaw, 1998). Travel sickness had no effect on meat quality (Bradshaw *et al.* (1999). In addition, there is evidence that feeding up to collection leads to a higher transport mortality (see review by Warriss, 1998).

The scientific evidence for an optimal fasting time in relation to travel sickness is sparse. Warriss (1994) recommended that the last feed before collection should be between 4 and 12 hours. However, Warriss (1998) stated that for journeys on poor roads or in vehicles with poor vibration characteristics four hours fasting was likely to be too short. Fasting times have more often been set for food safety reasons, so that gut contents are low at slaughter, thereby reducing the risk of carcass contamination. 10-12 hours fasting is recommended to accomplish this (Lambooj *et al.* 1999).

However, much longer fasting times before collection are used in some European countries with up to 36 hours being reported in some research (Fraqueza *et al.*, 1998; Santos *et al.*, 1996). Clearly such long fasting times have substantial negative effects on animal welfare. Moreover, they will lead to weight loss and a reduction in carcass yield in slaughter pigs. Loss in carcass weight is first thought to occur about 18 hours after the last feed and this weight loss continues at a rate of 0.13 % per hour up till about 48 hours, which was the maximum fasting time used in the work reported (Warriss, 1982). Liver weights decreased by 0.7 % per hour until 24 hours after which they stabilised. The author concluded that fasting should not exceed this length of time. However, pigs must be very hungry before this time and Brown *et al.* (1999) showed that with five hours fasting before transport, pigs both ate and drank in the lairage after 8, 16 and particularly 24 hours transport.

8.3.3. *Journey plan*

Careful planning of the journey is mainly of importance for long distance transport, where it is essential that stops for inspection, watering and feeding

are planned in advance. The vehicle must have water tanks for watering during the start of the journey and facilities for refilling the tanks, if these are empty. In addition, sufficient feed for the whole of the journey must be carried on the vehicle, as well as bedding, so that the deep layer of absorbent bedding at the start of the journey can be topped up, if necessary, to ensure that the pigs remain dry during the journey.

8.3.4. *Driving quality*

Christensen and Barton Gade (1996) showed that events such as sudden braking, negotiating roundabouts etc. led to short term increases in heart rate in pigs during transport. Bradshaw *et al.* (1996a) showed that plasma cortisol levels increased in pigs after loading and remained higher for longer for rough rather than smooth journeys. It should be noted that Bradshaw's work was not carried out under commercial conditions. Pig groups were small, space allowances large (0.49 m² per 90 kg pig) and the vehicle was semi-laden. It was a commercial vehicle but like many of these, its vibration characteristics were not optimal (Randall *et al.*, 1996).

While the type of road to be traversed cannot always be chosen, the way that drivers brake, negotiate bends and roundabouts etc. can be optimised. All drivers responsible for the transport of animals must have attended a training course and received a certificate of competence, unless they can prove that they have wide experience and can demonstrate their knowledge of pigs' needs.

8.3.5. *Travel times*

During transport pigs will gradually relax and heart rates and cortisol concentrations fall as the journey progresses, but they seldom drop to the basal levels as is the case with sheep and cattle in good conditions (Bradshaw *et al.* 1996a; Schütte *et al.*, 1996; Christensen and Barton Gade, 1996).

8.3.6. *Feeding and watering*

Lambooj *et al.* (1985) showed that water consumption is low during long distance transports of slaughter pigs. However, it was not possible to see from the article, whether drinking occurred when the vehicle was stationary or whether it also occurred when the vehicle was moving, or at which point pigs began to drink water. Barton Gade and Vorup (pers. comm.) followed long distance transports of weaners from Denmark to Holland and showed that it was first after 8 hours transport that most weaners would drink. However, it was necessary to wake them up first.

There is no scientific reason for demanding that pigs should have constant access to water during vehicle movement. It is unlikely that even thirsty pigs will drink from a nipple, when the vehicle is moving. Water should therefore first be offered during stops for inspection or driver's breaks during the journey. In this way water spillage due to pigs lying against the nipple will be avoided. It has been found to be advantageous to demonstrate to the pigs being transported that there is water in the nipple during the first stop with

watering. In this way they quickly become accustomed to the fact that there is water in the nipple and that this is available when the vehicle stops.

There is no scientific documentation regarding intervals for watering pigs in the transport situation. Using a space allowance of 0.50-0.54 m² per 100 kg pig Brown *et al.* (1999) compared constant transport for 8, 16 and 24 hours without resting periods or watering/feeding and observed the need for pigs to drink and feed during a six hour lairage period. The results showed that even though the environmental temperatures were relatively mild (14-20 C), all pigs drank and ate during the lairage period and that in particular pigs transported for 8 hours ate and drank immediately after arrival before they rested.

According to Council Regulation (EEC) No 3820/85 of 20 December 1985 drivers must observe a break of at least 45 minutes after four and half hours driving, unless he begins a rest period, and in each 24 hour period he must have a break of at least nine consecutive hours. Water should be offered to pigs 8 hours after the start of the journey at the latest and be available for the whole of the period where the vehicle is stationary. After the first 8 hours it should be available whenever the driver takes a break.

Regarding feeding pigs during transport, a similar situation pertains but here there is a conflict of interest: the animals are hungry but pigs with full stomachs risk travel sickness and a higher mortality. Pigs should therefore always have a break of at least 8 hours per 24 hours. Feed can then be offered in connection with the longest driver break. Light rations should be used.

8.3.6. *Staging points*

During transport, unloading during the journey will increase stress levels and the risk of injury. Moreover, there will be a risk of spreading disease and compromising the high health status of pigs which will be used for breeding or further rearing. If compartment groups on the vehicle are mixed at the staging point, then there will be fighting amongst pigs with poorer welfare and the risk of injury as a result.

8.4. **Sheep**

Journey management includes reducing the movement of the vehicle and considering staging points when the journey is long.

8.4.1. *Movement of the vehicle*

Sheep may find the movement of the vehicle aversive. Baldock and Sibly (1990) found that heart rate of sheep did not increase when animals were put into a stationary vehicle, but it did when they were transported. Therefore, it is likely that sheep are more stressed during rough journeys than during smooth ones. Ruiz de la Torre *et al.* (2001) compared the stress response and meat quality of sheep transported on smooth versus rough roads. Lambs transported on smooth roads had a lower heart rate and lower plasma cortisol concentrations after 8 and 12 hours than the lambs transported on rougher roads. Also, 24 hours after slaughter the pH of the meat of the lambs transported on smooth roads was lower than that of the lambs transported on

rougher roads, suggesting that the latter may have suffered muscular fatigue, leading to reduce muscle glycogen stores. Similarly, Hall *et al.* (1998c) found higher plasma cortisol concentrations on sheep transported on rough journeys compared with sheep on smooth journeys. As the roughness of a journey depends on road conditions and driving style, both training of drivers and planning of the journey should be recommended to reduce the movement of the vehicle.

8.4.2. *Travel times and staging points*

Transport can involve long periods without food and water. Although sheep are buffered against food and water deprivation by their rumen and have lower water requirements than other farm species, lack of food or water can cause welfare problems.

With longer journeys, there is a progressive loss of body and carcass weight, the latter being a better indication of the extent to which sheep draw on body reserves (Knowles, 1998). Liveweight loss has been reported at 5.5-6% after 15 hours of transport (Broom *et al.*, 1996; Knowles *et al.*, 1996) and at 7-8% after 24 hours of transport (Knowles *et al.*, 1995, 1996). Most of the loss occurred during the first 15 hours and was due to loss of gut fill (Knowles, 1998). Carcass weight has been found to decrease by 2.5, 3.8 and 5.8% after 24, 48 and 72 of food and water deprivation respectively (Warriss *et al.*, 1987). Plasma levels of hydroxybutyrate also increase progressively with fasting time (Warriss *et al.*, 1989). As these physiological changes do not show any obvious break point, it may be difficult to establish a maximum period of time during which sheep can safely be deprived of food. Nevertheless, after 12 hours of deprivation sheep become very eager to eat (Knowles, 1998).

As for water deprivation sheep seem to be well adapted to drought, as they are able to produce dry faeces and concentrated urine. In addition, their rumen can act as a buffer against dehydration. The effects of water deprivation seem to be largely dependent on ambient temperatures, as would be expected. For example, Knowles *et al.* (1993) found no evidence of dehydration during journeys of up to 24 hours when ambient temperatures were not above 20 C. However, when ambient temperatures did rise above 20 C for a large part of the journey, there were clear indications that animals became dehydrated (Knowles *et al.*, 1994b).

If resting periods within the journey are considered as a means to prevent the effects of food and water deprivation several points have to be taken into account. First, short resting periods –of one hour, for example- are insufficient and may even have detrimental effects on welfare. Hall *et al.* (1997) studied the feeding behaviour of sheep after 14 hours of deprivation and concluded that the extent to which sheep obtained food and water within the first hour was generally low or unbalanced. Knowles *et al.* (1993) found that recovery after long journeys took place over three phases and that after 24 hours of lairage sheep seemed to have recovered from short term stress and dehydration. It has been suggested that at least eight hours of lairage are needed to gain any real benefit (Knowles, 1998). A further problem is that sheep will not readily drink from unfamiliar water sources, even after

prolonged periods of water deprivation (Knowles *et al.*, 1993). Therefore, it is likely that during short resting periods sheep will not drink and the food they eat may lead to an increased water deficit, particularly if given concentrates (Hall *et al.*, 1997).

A second problem is that feeding during resting periods may cause competition between animals, and the stronger individuals may exclude the weaker ones (Hall *et al.*, 1997). It is therefore important that feeding and drinking space is enough for all animals to have access to food and water simultaneously. Recommended trough space for sheep is $0.112 W^{0.33}$ metres (Baxter, 1992). This means 30 cm for sheep of 20 kg bodyweight and about 34 cm for sheep of 30 kg bodyweight.

Finally, sheep can be reluctant to eat during lairage, particularly adult animals that are unfamiliar with the feed. Hay has been found to be the most widely accepted form of feed (Knowles, 1998), although Hall *et al.* (1997) found that only small amounts of hay were eaten by sheep after 14 hours of food deprivation.

An important decision to be made concerning resting periods is whether the animals are fed and watered on the vehicle or after being unloaded. Feeding and watering sheep in a normal commercial load may not be practicable, mainly because it would be difficult for all animals to have access to food and water simultaneously (Knowles, 1998). However, unloading the animals raises several problems, including an increased risk of disease transmission and the fact that loading and unloading are reported to be the most stressful parts of transport (see below).

8.5. Cattle

8.5.1. Introduction

About 82 million calves and adult cattle are kept in the European Union, 24 million of these are younger than 1 year of age; more than 22 million cattle and nearly 6 million calves are slaughtered per year. Trade in cattle between countries of the EU, imports and exports to other countries reach a total of 4,094,108 animals per year (Nagel, 2001). Table 4 gives a brief survey on the movements of cattle within the EU.

Table 4: A brief survey on cattle transportation in Europe (Nagel, 2001)

		Cattle			
A. total numbers:		82 775 132 animals (Dec. 1998)			
- less than 1 year of age:		24 079 245			
- others:		58 695 887			
B. Slaughter:					
Cattle:		22 070 695 animals			
<hr/>					
Calves:		5 793 395 animals			
<hr/>					
C. Trade:		number of animals			
<hr/>					
		inside the	imports from	exports to	Total
		Europ. Union	other countries	other countries	
<hr/>					
Breeding cattle:	134 315	4 747	101 812	240 874	
calves:	1 092 512	316 880	64	1 409 456	
cattle:	2 018 210	196 788	228 780	2 443 778	
total:	3 245 037	518 415	330 656	4 094 108	

From the figures it can be estimated that more than 30 million cows, beef cattle and calves are transported within the European Union per year. Most animals are transported directly to the slaughter houses or they are passing through markets or sampling points where they are unloaded, sold and loaded again before they are going to an abattoir. These figures do not reflect the local sales and transports between farms. The length of the journey and the purpose of the trade largely determine the type of transport vehicle and the preparation of the journey.

Depending on demand and market prices the animals may travel considerable distances within the European Union. Outside the EU preferred destinations for beef cattle are countries in the near east region; breeding cattle are likely to be exported to countries such as the former Yugoslavia, Egypt, or some North African states. Those journeys usually last longer than 8 hours and are carried out by special vehicles.

Current legislation on cattle transportation is given in the EU guideline 91/628 from Nov., 19th 1991, amended by EU guideline 95/29 from June, 29th 1995. Important rules are given in the EU Directive No. 1255/97 considering the requirements on staging posts and Directive No. 411/98 on requirements and equipment of vehicles for road transportation. Furthermore there is Directive No. 615/98, which regulates the export refund system. Export companies are paid a certain amount of money by the EU to make European beef competitive on world markets. This type of subsidy was designed to help to regulate the intra EU beef market and to support the "home" industry. At the same time it caused an increase in exports and long distance transports. Very often these long distance transports combine travel by road and ship, e.g. to North Africa or to Lebanon. In this case the animals are driven either directly on board together with the lorry and stay on their lorries during the journey (roll-on /roll-off) or they are unloaded and transferred to more or less

well equipped animal transport ships which sail the routes of the Mediterranean sea. Very few train transports were carried out in the past. In Germany the Deutsche Bahn (German Rail) decided to stop all farm animal transports by the end of 2000. The proportion of cattle which transported by aircraft is relatively small. These are usually valuable breeding cows going e.g. to Saudi Arabia.

Calves can be defined as young cattle up to the age of 6 months. The term "calf" can therefore apply to a wide range of sizes and ages of animal. Some calves can be transported at one week of age when they may be very vulnerable. Transported calves show typical stress responses to transport. These have been reviewed by Trunkfield and Broom (1990). They include activation of the hypothalamo-adrenal axis, changes in white blood cell levels and blood proteins, including enzymes, reduced immune system responsiveness and physiological responses such as increased heart rate. Much of the response is probably attributable to the initial stress of handling and loading. A series of studies by Kent and Ewbank (1983, 1986^a, 1986^b) indicated a large age effect in the response to transport. Young calves 1-3 weeks old were apparently least affected whereas older calves responded more.

Handling of calves is influenced by their age. Groups of very young calves do not show the following behaviour characteristic of older cattle (except they will follow their mothers). They may therefore need to be handled individually. Trunkfield *et al.* (1991) noted a difference in the behaviour of Dutch calves reared in crates, and those reared group-reared in pens, when they were transported. Crate-reared calves had considerable difficulty in walking up the loading ramp compared with group-reared animals. They also had higher salivary and blood cortisol levels after handling and transport. Rearing experience may therefore affect both the ease of handling calves and the animals' response to this handling and transport.

Todd *et al.* (2000) investigated the potential welfare of calves in New Zealand. Food withdrawal for up to 30 hours caused hypoglycaemia and circulating beta-hydroxybutyrate concentrations increased, indicating that the calves were mobilizing fat reserves to supply their metabolic needs. However, there were minimal changes in plasma urea, indicating that the calves were not breaking down proteins, and they maintained a normal body temperature. Additional transport for 12 hours did not cause any immediate detrimental effects. Calves did not become dehydrated. The authors therefore concluded that 30 hours without food and transport for up to 12 hours did not result in poor welfare in healthy and clinically normal calves. However, they cautioned that this applied only to calves slaughtered soon after transport, pointing out that there is evidence that transported calves can show high mortality and morbidity rates during the weeks following transport (Knowles, 1995). This suggests that there could still be detrimental effects of handling and transport that are only manifested later.

Knowles *et al.* (1999) transported calves less than 4 weeks old for 19 hours (including a 1 hour rest stop). When carried out in winter the calves lost more live weight and their body temperature declined. Feeding calves glucose/electrolyte solution during the rest stop had a small benefit in

reducing the extent of dehydration but offering water alone was not beneficial. The authors concluded that on balance it was preferable not to feed calves during an 18-hour journey since the handling and stress associated with the procedure outweighed any advantages.

Based on observations of Friesian calves 7 to 15 days old exported from the UK, Atkinson (1992) suggested that smaller calves were more adversely affected by transport. After transport, calves spent more time resting or sleeping than expected from published descriptions of the behaviour of non-transported calves. In very young calves (1-4 days old) in North America higher mortality post transport has been observed in the younger animals even if death occurred much later when the animals were 21 to 30 days old (Barnes *et al.*, 1975). Similar findings have been recorded for older (less than 1 to over 3 weeks old) calves by Staples and Haugse (1974). Knowles (1995) reviewing post transport mortality in calves suggested that animals below at least 4 weeks old should not be marketed. Calves from different sources should be mixed as little as possible. Greater mixing has been associated with a subsequent greater prevalence of diseases such as fatal fibrinous pneumonia (Ribble *et al.*, 1995).

8.5.2. *Preparation of animals and farm conditions*

Cattle are probably better able to withstand the rigours of transport, and especially the disruption in their normal intake of food and water, if they are fully hydrated and have been appropriately fed before loading. Adult cattle may require 40 litres of water a day, milking cows up to 180 litres. Actual intake will depend on type of feeding system, in particular whether the animals are grazing pasture or being fed concentrates, and the moisture content of the feed.

Eldridge *et al.*, (1989) suggested that before transport cattle should be well rested and have ample access to good quality feed. This however should be withdrawn 12 hours before loading. Water should be available at all times. Transporting cattle immediately off pasture or off concentrate feed can lead to dirty coats through faecal soiling. Because there are restrictions on the slaughter of dirty animals in slaughter plants in several Member States, this may have welfare implications. For example, in extreme cases very dirty cattle may be returned to the owner so increasing handling and transport.

If cattle are fully hydrated and fed before transport it is likely that food deprivation, rather than water deprivation, will be the greater stressor over the initial 24 hours of deprivation since this is more likely to disrupt rumen function. In pregnant heifers, and probably in other bovines, feeding during rest stops is beneficial. Either good quality hay or more energy rich foodstuffs may be suitable (Hartung *et al.*, 2000).

Generally, background information on the conditions of the farms the animals are originating from, would be desirable in order to complete the data of the animals transported, regarding their health status (e.g. vaccination programmes or immune status of the specific herd), the feeding regime etc., for preparing the animals properly and planning the transport accurately.

Unfortunately under commercial condition this is only practised with breeding cattle. Where as slaughter cattle is not selected with as much care as breeding cattle, it is usually picked up from the farms the day of transport itself. With breeding cattle, the animals are usually carefully selected, and arrive some days before transport in collection stations. This has also the benefit, that those animals can be put under the same feeding regime and gradually adapt them to the feeding in regard to the transport.

8.5.3. *Vehicle design*

Design of livestock transport vehicles in different countries varies according to what is practical for each country (Atkinson, 2000). An investigation of pig transport conditions in the EU found that the general design of animal transport vehicles was relatively constant within any one country, but varied between countries influenced mainly by climate (Christensen *et al.* 1994) and it seems not unlikely that a similar situation would exist for cattle transport vehicles.

There are various types of vehicles used for cattle transportation especially on shorter transports. For those legal requirements are more or less only defined regarding the space allowance. For transports between farms or to the local markets farm owned trailers for one or two cows are used. Traders often have road trains or one tiered lorries for the near market transport.

Transported cattle may be penned in groups (usually of between 4 and 8 animals) or individually, or individually haltered. Individual penning or haltering prevents agonistic or other interactions between animals, particularly if these are unfamiliar individuals, perhaps collected from a number of different rearing farms. This is especially true for young bulls. A problem with individual haltering is that to prevent interactions and entanglements the halter rope must be short. But, short ropes may impede the animal's ability to lie down and be dangerous to it if it falls.

Lambooy and Hulsegge (1988) transported heifers (500kg) for 24 hours at a stocking density of 300-350 kg/ m² either loose in groups of 8 animals or penned in pairs using gates (arranged transversely to the direction of travel). The heifers transported loose lost more weight and drank less water during a 3 hour rest stop than penned heifers. The loose-transported animals hardly lay down at all but the animals penned in pairs did. Where one member of the pair lay down this made it difficult for the remaining animal to stand and there was a real danger of it falling and injuring of the recumbent animal. Moreover, about a quarter of the penned animals showed trauma in the form of skin lesions around the hip bone and knee after transport. No damage occurred in the loose-penned animals. It was concluded that penning in loose groups was preferable. However, Hartung *et al* (2000) found that pregnant heifers in groups of six lay down readily if given enough space. On a motorway they lay down after 3-4 hours of travel at quite low stocking density.

Commonly used in long distance cattle transport are double decked semi-trailers, trailers and road trains, each with four or five pens. In most modern lorries the upper floor is movable. The animals enter the lorry by a normal

ramp. After loading the deck is lifted up and the lower deck is loaded. Water and food have to be delivered in all pens. It is important that the animals are familiar with the type of drinking facility, otherwise there is the risk of non or too little water consumption and dehydration. Cattle are mostly used to troughs or bowls. Calves and younger cattle may also accept hose nozzles. Experience showed that heifers used to bowl drinkers only were unable to operate hose nozzles during the journey and dehydrated. After a journey of 500 km no water was consumed. Dehydration is a commonly observed problem on long distance transports, which resolves quickly as soon as the animals have free access to water. (Knowles, 1999, 1999b, and 1997; Warriss *et al.*, 1995).

Another critical point is ventilation. Ventilation systems in vehicles are either free or forced ventilation. Whereas in vehicles used for transportation of less than 8 hours it is more likely to find free ventilation systems, in special vehicles for long distance transport forced ventilation is usual. Especially when going from northern Europe to Mediterranean regions the difference in climate underlines the importance of efficient ventilation systems of trucks. But also frequent stops through traffic jams or border controls involve the risk of heat building up inside the vehicle (Warriss, 1996; Grandin, 2000). Therefore, in order to safeguard the health and well-being of the animals, controlled mechanical ventilation systems should be provided.

In some countries special vehicles have been designed for the transport of cattle only. In Finland a completely enclosed semi-trailer with single pens for the transport of up to 17 animals is commercially used. The single deck compartments are fully air conditioned. In winter heat is supplied, in summer cooling is provided. The vehicles are used for long distance transport (Honkavaara, 2000). In Germany a two-deck vehicle with 5 pens for up to 40 cattle is in use. The floor of the second deck is solid. The animals reach the upper deck by means of an extended ramp. Bowl drinkers, mechanical ventilation, air suspension and a feed store for longer journeys are provided. A vehicle for cattle transport which permits all individuals to drink as soon as the vehicle stops is described by Chupin *et al.* (2000b). Recently pneumatic suspensions have been recommended for animal transport vehicles by Grandin (2000).

8.5.4. *Space requirements and ventilation for cattle transporters*

Randall (1993) pointed out that there were two possible types of criteria for deciding the acceptability of stocking densities. One related to the amount of space the animal physically occupies, the other to the provision of adequate ventilation. Ventilation is also a function of vehicle design. Ventilation in traditional designs of cattle transporters in Europe is provided passively through ventilation slots along the sides of the vehicle. However, in some North American vehicles the vehicle sides have numerous perforations to allow air movement. Correct ventilation is important in allowing animals to lose heat at high ambient temperatures while avoiding hypothermia at low ambient temperatures. It must also prevent the build-up of high concentrations of carbon dioxide from exhalation and ammonia from the breakdown of faeces and urine. Randall (1993) recommended that the maximum levels of these two gases in the atmosphere within the transporter

should be 3 ml /L (3 parts per thousand) for carbon dioxide and 0.02 ml/L (20 parts per million) for ammonia. Ventilation rates should therefore allow a sufficient number of exchanges of air to prevent gas concentrations higher than this.

An important point made by Randall (1993) was that, when ventilation was through slots, it should not be possible for these to be occluded by animals, such that air movement was obstructed. The ideal way of ensuring this is for the slots to be above the level of the animal's back.

Because the height of cattle varies considerably it is not possible to specify a universally applicable minimum deck height in absolute terms. However, this should provide for sufficient space for adequate ventilation. An appropriate specification might be a minimum of 20cm clear space above the highest part of the tallest animal carried when standing in any normal position.

The space above the animals' backs is important for ventilation. However, the temperature (and usually the humidity) of the air over the heads of animals in standard transporters tends to be very close to that of the external atmosphere (Warriss *et al.*, 1995) with adequate ventilation slot area. The air temperature above the animal's heads reflects the balance between heat produced by their bodies and its removal in the airflow induced by the vehicle's ventilation. At high stocking densities, loss of heat from animals' bodies may be inhibited by the reduction in effective surface area to dissipate it because animals are touching one another.

Randall (1993) recommended that a temperature of 30C should not be exceeded for cattle. At temperatures approaching, and above this, humidity becomes important with high relative humidities being deleterious. At lower temperatures humidity is not important. The Report from the Commission to the Council and the European Parliament on the application of the different ventilation systems for animal transport vehicles for road journeys exceeding eight hours (Brussels 09.04.2001 COM (2001) 197 final) specifies that the maximum temperature that cattle of all ages should be subjected to is 30 C at relative humidities less than 80%. At higher relative humidities (greater than 80%) the maximum acceptable temperature is 27 C. The Report also specifies minimum acceptable temperatures. These are higher for smaller cattle. For calves 0 – 2 weeks old the minimum acceptable temperature is 10 C, for animals between 2 and 26 weeks it is 5 C and for animals older than 26 weeks it is 0C.

8.5.5. *Behaviour of cattle during road transport*

Adult cattle appear to prefer to stand during transport (Knowles, 1999), however they will lie down after long transport, presumably because of fatigue. Tarrant *et al.* (1992) found that cattle weighing 600kg began to lie down after 16 hours of transport if they were given sufficient space. Warriss *et al.* (1995) found that steers weighing on average 340kg and transported at a space allowance of about 1 m² per animal for 15 hours appeared fatigued, based on their relative docility during subsequent handling, but did not lie down during the journey. The suggestion that they were fatigued was supported by progressive increases in the blood plasma activities of the

muscle enzyme creatine kinase (CK) which remained high for two days after transport.

Knowles *et al.* (1999) transported cattle weighing about 570kg for 31 hours with a 1 hour rest stop after 14 hours. Some animals started lying down after about 20 hours of transport. In total, seven of the 15 animals that were monitored constantly during the journeys lay down. Based on these observations the authors suggested the maximum allowable journey time would more appropriately be 24 hours, rather than the currently permitted 31 hours. Twenty-four, rather than 20 hours, was suggested because only one animal lay down before this time. However, Marahrens and Hartung (pers.com.) found that all pregnant heifers lay down without adverse effects given sufficient space and good driving.

The observations that groups of adult cattle prefer not to lie down during transport may reflect the difficulty of doing so safely when in groups. Honkavaara (1993) noted that when animals were transported in stock crates designed for two animals, an animal often lay down after only 2 or 3 hours. Therefore, it may be that under circumstances where they can lie down safely, cattle in fact will do so. This would give added weight to the view that long transport is fatiguing for cattle.

The implication of these observations is that for journeys longer than 20 hours, and certainly longer than 24 hours, space allowances should be increased to enable adult cattle to lie down easily. It is not clear by how much, but animals need enough room to get down and rise again. When one or more animals lies down it also becomes more difficult for the others in the pen to keep their balance while standing, and some animals fall down under these conditions (Knowles *et al.*, 1999).

The shape of the pen on the vehicle may be significant since for large animals, such as adult cattle, it may influence their ability to orientate in relation to the direction of travel. Cattle prefer to travel either perpendicular to, or parallel to, the direction of travel, rather than diagonally (Tarrant and Grandin, 2000). The dimensions of the pens on the vehicle should facilitate this. At high stocking densities this may be more critical. Knowles (1999) pointed out that there is probably an interaction between stocking density, group size and pen size.

8.5.6. *Road conditions*

Beside the vehicle design and equipment there are many more factors involved which can significantly influence the comfort of travel, such as type of road, road surface, windy roads, traffic density and frequent stop and go situations. A high degree of skill is required from the driver who can significantly influence the animals' comfort by driving carefully and choosing quiet routes which are less prone to traffic congestion. After 4 to 5 hours of quiet driving cattle start to lay down. When the breaks are frequently used followed by fast acceleration or sharp turn are carried out the animals will immediately stand up again. A lorry with 25 oxen was caught in stop and go traffic for three hours on its way to the abattoir. Half of the animals developed DFD meat after slaughter (Solms, 1999, pers. communication). In pigs it was

demonstrated that the heart frequency curve of the transported animals can reflect the type (district, federal motorway) and the quality of the road surface (Steffens, 1998). Similar observations are true for cattle.

8.5.7. Long distance transport

First problems on long distance transports arise before the actual transport has started. Slaughter cattle are usually transported in smaller vehicles to collecting stations. This includes loading and unloading, followed by regrouping. Regrouping especially, as stated by many authors, represents a stressful event for the animals, in particular to those animals that have had little previous experience of humans, such handling-procedures etc. (Kenny and Tarrant, 1987; Trunkfield 1990; Lensink *et al.*, 2001). In contrast, the loading itself and the ramp design are minor problems for adult cattle (Tarrant, 1990).

Generally during transport a change in the feeding regime takes place. Knowles (1999a, 1997) observed that feeding calves regularly during transport with electrolytes has positive effects on the problem of dehydration, but only the process does if not lead to prolonging the total transport time.

A number of experiments have investigated the effects of journey length. The majority of authors state that, with increasing duration of the transport, the negative effect on the animals increases as well, as represented through various physiological parameters such as bodyweight CK, NEFA, BHB, total protein etc. A period of food and water deprivation of 14 hours results in vigorous attempts to obtain food and water when the opportunity arises but deprivation must be for 24 hours before blood physiology changes in calcium, phosphorus, potassium, sodium, osmolarity and urea are apparent (Chupin *et al.*, 2000a). However, food and water deprivation during a journey are likely to have much greater and more rapid effects. The extent of energy deficit when cattle were transported for two successive journeys of 29 hours with a 24 hour rest between them was quantified by Marahrens *et al.* (pers. comm.). After 14 hours of transport the rules demand a break of at least one hour for feeding and watering of the animals. Most experiments have shown that because one hour does not give ruminants enough time for sufficient food and water intake, but therefore prolongs the total duration of the journey (Knowles and Warriss 1997 and 1999; Knowles 1999a,b).

Tarrant and Grandin (2000) claim that the total journey time is less of a problem than the condition under which the transport takes place. They assume that after the animal has adapted to the situation, time is a minor problem compared to loading densities, vehicle design, road conditions, driving behaviour of the driver etc. However, cattle become more fatigued as journeys continue. Brulé *et al.* (2001 in press) reported that there were more frequent losses of balance by transported cattle (959) during the second half of a 29 hour journey than during the first half (470). The losses of balance occurred much more often in the posterior part of the vehicle than in the anterior or central part. Loss of balance is a major problem for transported cattle.

After 29 hours of driving, a break of at least 24 hours is required, with unloading of the animals into a supply station. Experiments by Knowles und Warriss (1997 and 1999b) indicate that the majority of physiological parameters returned to pre-transport values after 24 hours of recovery. However, these breaks prolong the total journey time considerably.

8.5.8. *Staging post/supply stations*

The EU Directive 1255/97 regulates the requirements for staging posts. This includes rules on hygiene and disinfection of the facilities, adequate feeding and watering for the animals, and the requirement that facilities have to be designed to guarantee no re-mixing of different animal groups, and that skilled staff have to be present.

It is also important that the facilities are equipped that they can be adjusted to the demand of the type of animals that are placed there, since the animals might vary from young calves over dairy cows to adult bulls, so that their needs can be met.

For example bulls in a larger group placed in a pen without facilities to prevent them from mounting will not most likely engage in physical activity with very little benefit from resting period. The aggressive behaviour is among other factors influenced by group size and stocking density (Tennessen, 1984).

Experiments have shown that female breeding cattle that were not unloaded for the resting period, but kept on the vehicle, which was stationary during those 24 hours, had better resting values than those animals that were unloaded and reloaded, provided that the loading densities were not too high (Marahrens and Hartung, 2000, ADR-Report unpublished).

The staging posts and the resting period of 24 hours create difficulties for cattle which are exported for breeding purposes. Usually the company that buys the animals asks for a certificate which states that the animals had no contact with other cattle during the three days preceding the delivery. The group of animals to be exported is usually housed separately for about a week before the journey travel. All animals are carefully inspected for injuries and diseases. In the staging posts it can't be guaranteed that there is no contact to other animals. Therefore it seems better to feed and water the animals on the lorry to avoid unloading and reloading.

8.5.9. *Travel times*

During transport animals are exposed to a variety of similar and repeatedly occurring stressors which can be of mechanical, climatic, acoustical, nutritional or of social nature. These factors can act together or as single events.

Most investigations on cattle transport are related to journeys between several hours up to 24 hours. Longer transport times were investigated by Mormede *et al.* (1982), Locatelli *et al.* (1987), Simensen *et al.* (1980) und Soissons *et al.* (1982). Blood samples were taken from calves before and after journeys of 30 resp. 48 hours in order to find changes in blood constituents which may

give an indication of stress. Cortisol is one of the most frequently measured parameters. The highest concentrations are usually found after loading and during the first few hours of the journey (Kent and Ewbank 1986; Kenny and Tarrant 1987a,b).

8.6. Conclusions

High temperatures in transport vehicles often cause poor welfare and mortality. The effects are worse if humidity is also high, a common condition in vehicles especially those which are not well ventilated. Severe problems arise if vehicles remain stationary in direct sunlight on warm days. On warm days, the animals are at risk whenever the vehicle is stationary, including periods after arrival at a slaughterhouse or other destination. A system of ventilation openings and forced ventilation which can operate independently of the vehicle engine substantially reduces risk of animals overheating.

The quality of the suspension system of a transport vehicle and the presence or absence of good insulation in the walls and roof can have a considerable effect on animal welfare.

During transport the metabolism of the animals is moderately increased, as shown by slightly higher concentrations of thyroxine and tri-iodothyronine in the blood. As the journey proceeds, the animals develop an energy deficit and mobilisation of body energy reserves compensates for this. An adequate feeding regime before they travel and during the journey can help to prevent an energy deficit.

Where journeys last for 8 hours (pigs, calves, lambs and horses) or 12 hours (cattle and sheep), the animals will have become fatigued and will need to rest. They seldom eat or drink during substantial vehicle movement so they will also need to stop to consume food and water, except that on motorway journeys, cattle and sheep will eat. A rest period of six to eight hours allows some degree of recuperation after such periods of transport. [A rest period of nine hours is the minimum allowed for drivers after a day of driving.]

For good welfare during rest periods appropriate temperature and ventilation, supplies of food and water and sufficient space for all animals to be able to eat and drink are needed. Sick or injured animals can be off-loaded during rest periods.

A wide range of measures of physiological responses and increments in disease occurrence show that horse welfare during transport becomes considerably worse after 8-12 hours of transport without rest. Horses require food and water more frequently than do ruminants.

Horses may refuse water which has an unfamiliar taste.

Transporting horses for periods greater than 12 hours greatly increases their risk of developing shipping fever.

In horse trailers, air quality becomes worse over time and the effects of opening windows and vents are limited. This can result in respiratory pathology.

Pigs are susceptible to motion sickness during journeys and, as in humans, the motion sickness is associated with increased plasma vasopressin concentrations and retching. A period of food deprivation before transport reduces vomiting but probably does not affect motion sickness. Ruminants do not show retching but might still be affected by motion sickness.

Pigs travelling to slaughter are usually heavy in relation to leg strength and subject to cardiovascular problems. The fasting of pigs before transport is desirable. Pigs transported for eight hours or more are strongly motivated to eat and drink.

All pigs, cattle, sheep and horses which are unfamiliar with transport vehicles are substantially affected by being loaded on to and unloaded from a vehicle. The adverse effects are generally greatest for pigs. Unloading at a staging point and loading again would have a more adverse effect on all individuals than leaving them on the vehicle provided that the conditions on the vehicle are appropriate to the needs of the animals.

After a journey lasting 12 hours, sheep are highly motivated to eat. However they might not drink until two or three hours later so breaks lasting four hours or less will often cause dehydration and increased welfare problems for sheep. At temperatures of over 20 C, sheep become dehydrated during a 24 h journey.

9. ROLL-ON-ROLL-OFF TRANSPORT

9.1. Effects of roll-on roll-off ferries on welfare

Based on observations made in 1976 on calves, pigs and cattle transported from Plymouth (UK) to Roscoff (France) Brown (1979) identified a number of important requirements or concerns. In particular, these related to ventilation. There are problems for animals unless livestock vehicles are loaded last and unloaded first, and are parked in the hold near extractor fans with the ventilation openings completely opened. The problem of refrigerated vehicles parked close by and running their diesel generators continuously, so leading to the production of diesel fumes, was highlighted

Road transport is by far the commonest form of transport for slaughter and breeding animals in Europe. Nearly all destinations can be reached by road, except Ireland and Great Britain and other islands. If animals transported from or to these countries they have to go by sea. The same applies to exports to countries such as Algeria, Morocco, Tunisia or Lebanon. When using ships for animal transport two types of transport apply. Either the animals are unloaded from the lorries and they are loaded on the ship or the ship provides space for the whole lorry as it is known from ferries which can take on board dozens of lorries. The latter type of transport is called roll-on-roll-off. Roll-on-roll-off traffic exists between Ireland and UK and to the continental Europe.

The travel times vary between 90 minutes across the English Channel and a couple of days to the Lebanon or north Africa. In 1989 the UK transported to other EU countries by roll-on roll-off ferries 302,000 store calves, 492,000

sheep and 1300 pigs (Randall, 1993). The advantage of the roll-on roll-off system is that it is not necessary to unload the animals from the lorry, load them into the ship and then reverse the procedure at the destination. The travel time can be significantly shorter and the animals avoid the loading stress.

The welfare of the animals depends on the safe position of the lorry on the ship. In case of under deck parking, sufficient ventilation must be provided, such that the heat and gas exchange in the lorries can take place. Sufficient food and water must be provided on the lorries. Thermoregulation, oxygen supply and the removal of noxious gases is essential for the animals. Usually the parking decks are ventilated e.g. to remove the noxious vehicle exhaust fumes. The animal transporter provides natural ventilation only. Therefore it is necessary that the ventilation slots of the lorry are all open and that no obstacles hinder the circulation of the air in the deck space (Watts, 1981). Some lorries can lift the roof to enlarge the headroom above the animals and improve ventilation in the upperdeck. If several lorries are on the same ship and deck it is important that an air space of at least one width of a lorry is between two vehicles.

Because of the confined conditions if ventilation is poor, a stocking density on the lorries which is 10% lower, or 20% for pregnant animals, is necessary for acceptable welfare.

Further problems encountered with sea travel are travel sickness, abortion caused by rough sea, high noise levels in the ship and poor lighting. The abortion rate in cattle increases with increasing winds. It is reported that wind forces of 14 m/s (6 Beaufort) cause a reduced feed intake of cattle by about a third of normal. Above 7 Beaufort (17 m/s) the abortion rate increases among cattle kept under the main deck, above 8 Beaufort (20 m/s) abortions were observed among cattle on the main deck (Müller and von Hörsten, 1982). When the ships are rolling and pitching in the sea the lorries are moving accordingly. Particularly in the upper decks of lorries on the main deck the forces are very strong and the animals can develop motion or travel sickness (Platt, 1981). In the parking decks of the ferries the noise levels can be particularly high. Hall *et al.* (1999) found noise levels up to 103 dBA. A starting jet aircraft produces 110 dBA.

During a smooth voyage the heart frequencies of sheep can be lower than during the road transport (Hall *et al.*, 1999).

Adequate ventilation is the most important requirement for roll-on roll-off transport.

9.2. Conclusions

During roll-on roll-off ferry crossings, provided that ventilation is good and the sea is not too rough (wind up to force 4) sheep are less adversely affected than whilst driven along a road in a vehicle. Hence a sea crossing can be considered to be a rest period at such wind speeds. However, motion sickness, noise at a very aversive level, abortion and injury may occur at wind speeds of force 6 or above.

On roll-on roll-off ferries, thermoregulation, sufficiency of oxygen, the presence of noxious fumes, high noise levels and sea-induced movements can all be problems for the animals. Most of the worst problems are lessened if there is good air circulation between vehicles, through ventilation slots and amongst animals on vehicles.

10. FUTURE RESEARCH

1. Investigation of the role of transport in infectious disease transmission. A retrospective study of outbreaks to check whether animals were transported and the extents of contacts which might have led to pathogen transmission.
2. Susceptibility to infection in relation to the components of the transport process.
3. Effective identification and tracing systems for farm animals using modern and future technology.
4. Optimal handling for good welfare during transport.
5. Analysis of stocking density equations in relation to welfare.
6. To inform discussions about appropriate stocking densities and space allowance, measurements of the external body dimensions of animals are needed. This should cover animals of the whole range of weights seen commercially, including young animals and breeding stock, and encompass potential variation between animals in the different EU Member States.
7. Interactions among stressors associated with transport fatigue and food and water deprivation.
8. Interactions between stocking density, vehicle design, including insulation, deck height, ventilation and (for pigs) misting, in hot and cold weather.
9. Effects of multiple journeys on cattle, sheep and pigs and of periods of time required during rest stops to enable animals to consume sufficient food and water to assuage their hunger and thirst. The time required for recovery after a journey should be studied.
10. Effects of transport in groups on the welfare of slaughter horses.
11. Stall and trailer design in relation to welfare in transported horses.
12. Effects of different periods of standing during transport on the welfare of horses and cattle.
13. One of the major stresses of transport for some animals is the disruption of their normal feeding and drinking behaviour. Defining acceptable periods of food and water deprivation for each species is therefore important.

14. Space utilisation by transported cattle.
15. The use of preference studies to discover the level of aversiveness of different aspects of transport.
16. Effects of transport on the welfare of young lambs, calves, piglets and foals.
17. Effects of transport on the welfare of older breeding pigs, older dairy cows and older ewes.
18. Effects of sea conditions on the welfare of cattle, sheep, pigs and horses in roll-on, roll-off ferries.
19. Socioeconomic reasons for animal transport.

11. OVERALL CONCLUSIONS

Chapter 2 THE ASSESSMENT OF ANIMAL WELFARE DURING TRANSPORT AND ASSOCIATED HANDLING

1. The welfare of animals during handling and transport can be assessed using a range of measures of behavioural, physiological, biochemical, pathological and carcass condition changes. The frequency of injury, morbidity and mortality at the end of transport can also be measured and the magnitude of effects on previous welfare deduced.

Chapter 3 EFFECTS OF TRANSPORT ON LATER WELFARE, IN PARTICULAR DISEASE

2. Some pathogens that do not induce in a disease condition in farm animals kept under good conditions become activated during transport, often because of some degree of immunosuppression resulting from stress during transport. These pathogens, for example *Pasteurella* species and several rotaviruses and herpes viruses, proliferate and cause disease conditions in animals kept after transport.
3. Transported animals may become infected with pathogens that come from other individuals. Disease may also be transmitted to non-transported animals because of transport. Important diseases which might be transmitted in this way include foot and mouth disease, classical swine fever, bovine viral diarrhoea, swine vesicular disease, sheep scab, highly pathogenic avian influenza and Newcastle disease. The disease spread may occur over great distances because of transport. Transmission from infected transported animals is much more likely if other animals are brought into contact with them, or their products, at markets or at staging points than if there is no unloading from the vehicle.

Chapter 4 INSPECTION

4. Animals may be unfit to travel because they are injured or diseased, or because of their physiological state (of advanced pregnancy), or they may be fit to travel

only in better conditions than the minimal ones permitted by law or for a short journey rather than a long journey. The person responsible for the animals at the point of origin or during the journey can inspect the animals in order to decide whether or not they are fit to travel. During journeys, poor vehicle design or distribution of animals in the vehicle, or too high a stocking density, can prevent effective and safe inspection of each animal.

5. Where checks involving recognition of disease conditions are required before the journey commences, or where the person responsible for the animals carries out an inspection and suspects a disease condition which is of significance for the welfare of a particular animal or which is liable to be transmitted to other animals, inspection by a veterinarian is needed.
6. The timing of veterinary inspection is important. If it is not carried out immediately before transport there is an increased risk that animals will be unfit when transport commences or that a disease condition will develop during transport.
7. It may be necessary for animals to be humanely killed, using appropriate equipment, during a journey, or for animals to be unloaded at an appropriate place, or for a potentially important disease condition to be reported to the competent authority of the administrative region.
8. The detection of unduly long journeys and the tracing of the sources of animals that are found to be diseased are facilitated by effective systems for the identification of each individual animal and the keeping of proper records of transport. Marking methods which involve mutilation of animals involve poor welfare.

Chapter 5 **TRAINING AND PAYMENT OF PERSONNEL**

9. Some people who load or unload animals, or drive vehicles, do not treat the animals as sentient beings whose welfare should be safeguarded, or as the source of valuable commodities whose quality and value can be reduced by poor treatment. Many livestock vehicle drivers are unaware that when vehicles go around corners or bends, or are caused to accelerate or brake rapidly, the animals are thrown about or seriously disturbed much more readily than human passengers who are sitting on a seat or standing but holding on to a fitment attached to the vehicle. Hence the welfare of animals is often very poor during loading, unloading and transport, especially on winding roads.
10. The education of persons involved in handling animals, moving animals, or driving vehicles can greatly improve animal welfare. The payment of all such persons in a way which encourages rapid handling and fast driving usually results in very poor welfare and carcass quality.

Chapter 6 **LOADING METHODS HANDLING AND OTHER PREPARATION FOR TRANSPORT**

11. Horses, cattle, sheep and pigs have well developed senses and learning ability. The ability to feel pain and neural mechanisms of pain perception is similar to those of other mammals. They are highly social animals. They show behavioural and physiological responses to isolation, strong responses to other group members and they are frightened by unfamiliar situations and sounds.

12. When pigs or adult male cattle are mixed with strangers that come from other pens on the same or different farms, before or during transport, the animals may fight, there may be considerable fear and injury in some individuals, the meat may become dark, firm and dry and, in each of these circumstances the welfare will be poor. There can also be adverse effects of social mixing in calves and some horses and rams.
13. The use of a twitch, a thin rope twisted around the soft tissue in the region of a horse's nose, for facilitating horse handling prior to or after transport, probably causes severe pain on all occasions.
14. Beating or poking with a stick will cause pain to farm animals, especially in very sensitive areas like the eyes, mouth, ano-genital regions or belly.
15. When sheep are lifted or moved bodily by a human grasping them by their wool, substantial tissue damage is caused in the region grasped and this must be associated with considerable pain.
16. Electric goads can cause severe fear and pain and their use is associated with poor meat quality in pigs and other species.
17. For most livestock transport, loading, with associated handling or driving, is the most stressful part. Unloading is often also stressful. The disturbing aspects are fear, and sometimes pain, caused by humans; forced physical exercise especially on steep ramps; and stress caused by the unfamiliar loading procedure, vehicle conditions and social contacts. There is also increased risk of injury. Poor welfare during loading is evident from a range of measures including: stopping, turning and being difficult to drive, fear induced vocalisations, high heart rate, high cortisol concentration in plasma or saliva and high concentrations of other hormones.
18. Species vary in their responses to loading. Pigs are more readily affected by physical exercise whilst sheep are easily frightened by humans. Each species requires different handling procedures. Genetic strain also affects responses to loading and transport, for example all modern pig strains are adversely affected by the stresses associated with loading and transport and some strains, such as those bearing the halothane gene, are severely affected.
19. If animals have experience of loading and of transport in which conditions are good, they are likely to show much reduced responses to subsequent loading and transport. Horses which are frequently transported and sheep which have been transported on several occasions show fewer indications of poor welfare. Previous exposure to calm, friendly humans during rearing, even for short periods, reduces poor welfare during loading and transport. Animals with little previous human contact, or with experience of ill-treatment, are the most adversely affected by human handling and loading.
20. Horses can mount a step-up entrance to a transport vehicle but animals that have not had previous experience of such an entrance may balk. For animals which have not been loaded into a vehicle before, a ramp no steeper than 20° to the ground is less likely to cause problems.

21. Pigs, especially old sows, can have difficulty climbing any ramp, although 70-120 kg pigs can usually climb a non-slippery ramp of 9°. Ramps which pigs are required to climb cause substantial difficulty if they are steeper than 20°.
22. Sheep are readily frightened by poorly designed ramps, e.g. those without solid sides or which are slippery. Most sheep can climb steep slopes but the steeper slopes may lead to injury when sheep show a panic response.
23. Cattle can have problems when required to climb loading ramp slopes of 18° or steeper but with non-slip floors and appropriate cleats at 30 cm intervals, a 20° slope is readily climbed. Calves, especially those which have had little opportunity to exercise, require lower gradient loading ramps.

Chapter 7 SPACE ALLOWANCE

24. Transported animals require a certain floor space allowance in order to stand comfortably and keep their balance during vehicle movement. They require a larger space allowance to lie down and it is likely with any group of farm animals that there will be occasions when they all need to lie down at the same time. A yet higher space allowance is required for animals which have to walk around within the vehicle in order to obtain food or water whilst others may be lying down.
25. All farm animals which are standing during vehicle movement, attempt to stand in such a way that they maintain balance without any contact with other animals or with the vehicle walls. If the vehicle is driven properly they can and do avoid such contact. Avoidance of contact with other animals is also important if overheating is a potential problem. During rest periods, especially when temperatures are low or when the animals are disturbed and require social reassurance, pigs may lie and sheep may stand in physical contact with one another.
26. The floor space area which allows good welfare on transport vehicles will vary with the species, age, body weight, pregnant or non-pregnant state, presence or absence of fleece in sheep and presence or absence of horns in some cattle. The space can be quoted per unit weight of animal on different scales for different animals. The relationship between body weight and required floor area is not linear because the animal's weight is proportional to its volume. Hence the formulae which relate body weight to required floor area have an exponential component.
27. The height of compartments within which animals are transported is important in relation to the welfare of the animals in that the animal which is standing needs to adopt a comfortable posture unimpeded. It is also necessary for adequate temperature regulation and removal of noxious gases that the height of the compartment is adequate for effective ventilation to occur.
28. Horses almost always stand during transport, even on smooth journeys. They may stand or lie down when resting. Horses require a significant duration of true sleep, which is largely achieved at night and in a standing position. Transport may disrupt sleep patterns.

29. Stabled horses spend about 3 hours eating and a total time of 15 minutes drinking about 36 litres each day. In most situations horses drink several times a day, more in hot conditions. Food and water requirements will be greater during transport than in stables because of the energy needed for balance and higher metabolic rates.
30. A greater height is needed if no forced ventilation system is provided in the vehicle and the height required for ventilation above the highest point on the animal will vary according to the shape of the standing animal. Horses are susceptible to a range of problems during group transport situations. They do not adapt well physiologically to transport and they can easily injure one another when transported in groups. When horses fall during transport, they often have difficulty standing again if they are in a group. Most horses are transported in vehicles with individual places for each horse and appropriately designed partitions between these. Welfare problems are much less common in such transport conditions than when horses are grouped in pens on a vehicle.
31. Horses vary greatly in body size. The length and width of widely used stalls on vehicles can be inappropriate for the smallest or largest horses. The design of partitions is important in that if the space below partitions is too great horses can fall and be trapped under the partition and if the top of the partition is too low the bodies of the horses may not be adequately separated. Partitions which are well designed for the size of horse contribute to a good travelling environment.
32. Many horses have a preference for facing backwards in a trailer during road transport to maintain better balance.
33. Horses which are tied during transport, or limited in their movements by chest bars, or which are unable to lower their heads to shoulder height may become trapped or have breathing difficulties. Restraint of horses with their heads in an elevated position (cross-tying) during long journeys can contribute to the pathogenesis of the lower respiratory tract. Tying of cattle also causes problems because if the tie is too short, the animal will not be able to lie down and may be unable to stand up if it falls. If the tie is long enough to allow lying, the animal may step over the tie or otherwise become entangled in it. Welfare can be very poor in any of these circumstances.
34. At very high stocking densities, pigs forced to stand during vehicle locomotion had elevated creatine kinase activity in blood, a higher incidence of skin damage, more frequent rectal prolapses and much disturbance because of difficulty in obtaining space for standing.
35. Where vehicle movement, caused by swerving around corners and sudden braking and accelerating, is not too great, pigs of all ages which have been studied will lie down throughout vehicle locomotion. This is probably due in part to the fact that many pigs have some degree of leg disorder or are relatively heavy for their leg strength or naturally spend more time resting. The space required for pigs to lie simultaneously is 0.42 m² per 100 kg pig. At 0.35 m² if all try to lie down at the same time they have to lie on the sternum, or overlap or are unable to lie down. This stocking density causes problems. The problems are worse at temperatures of 20 C or over, where thermoregulation requires more separation

unless forced ventilation and misting are used.. Where watering and feeding on a vehicle are necessary, the space required is 0.6 m² per 100 kg pig.

36. The highest point on the body of young pigs is the top of the head but for older animals it is the centre of the back. The height of compartments for pigs needs to be calculated in relation to height above the highest part of the body. For 100 kg pigs ventilation can be adequate at a compartment height of 100 cm or even less but adequate inspection and access, for caring for weak animals, is not possible at this height.
37. Sheep travelling on journeys with little lateral movement or sudden acceleration will often remain standing for several hours but begin to lie down after 4 hours. When journeys are rough, for example when roads include many bends and vehicles are driven at a speed which is normal for human passengers, sheep will stand but will avoid contact with other individuals, thus requiring more space and their plasma cortisol levels will be much higher than those of sheep driven on straight roads or kept in stationary, well-ventilated vehicles.
38. The space needed by sheep during transport depends on body weight, presence or absence of wool and ambient temperature. Sheep need additional space to keep their balance on rough journeys. The space required for shorn sheep of 40 kg to stand on a vehicle is 0.24 m². For 40 kg sheep without a fleece to lie down, 0.31 m² is needed. For fleeced sheep 20% more space is needed. A shorn sheep is one in which the thickness of the uncompressed fleece is less than 1.5 cm.
39. Cattle may remain standing during transport of up to 20 hours duration, even if the vehicle is driven carefully. However, recent studies in which much bedding is used and journeys are on motorways, indicate that many cattle lie down after a few hours. If cattle fall during transport, they may have difficulty in standing up again. Young calves of up to three weeks of age lie down for a substantial part of every journey and three month-old calves lie down for a smaller part of each journey.
40. Cattle transported for 24 h had higher plasma cortisol, creatine kinase and carcass bruising, more losses of balance and more falls at a higher stocking density of 570 kg m⁻² than at 505 kg m⁻² or 440 kg m⁻². A density of 1.16 m² per animal caused few problems for 400 kg cattle. This figure conforms with the equation $A = 0.021 W^{0.67}$ (where A is area per animal in m² and W is weight of animal in kg).
41. The minimum space allowance for cattle to be able to lie down on a vehicle and have adequate access to food and water supply points is 40% greater than that required for standing or sternal lying.

Chapter 8 JOURNEY MANAGEMENT

42. High temperatures in transport vehicles often cause poor welfare and mortality. The effects are worse if humidity is also high, a common condition in transport vehicles especially those that are not well ventilated. Severe problems arise if vehicles remain stationary in direct sunlight on warm days. On warm days, transported animals are at risk whenever the vehicle is stationary, including periods after arrival at a slaughterhouse or other destination. A system of

ventilation openings and forced ventilation which can operate independently of the vehicle engine substantially reduces risk of animals overheating.

43. The quality of the suspension system of a transport vehicle and the presence or absence of good insulation in the walls and roof of a vehicle can have a considerable effect on animal welfare.
44. During transport the metabolism of the animals is moderately increased, as shown by slightly higher concentrations of thyroxine and tri-iodothyronine in the blood. As the journey proceeds, the animals develop an energy deficit and mobilisation of body energy reserves compensates for this. An adequate feeding regimen before they travel and during the journey can help to prevent an energy deficit.
45. Where journeys last for longer than 12 hours, animals of many species will become fatigued and will need to rest. They seldom eat or drink during vehicle movement so they will also need to stop to consume food and water, except that on motorway journeys, cattle and sheep will eat. A rest period of six to eight hours allows adequate recuperation after short periods of transport. A rest period of nine hours is a minimum for drivers.
46. For good welfare during rest periods appropriate temperature and ventilation and supplies of food and water and sufficient space for all animals to be able to eat and drink is needed. Sick or injured animals can be off-loaded during rest periods.
47. A wide range of measures of physiological responses and increments in disease occurrence show that horse welfare during transport becomes considerably worse after 8-12 hours of transport without rest. Transporting horses for periods greater than 12 hours greatly increases their risk of developing shipping fever. Horses require food and water more frequently than do ruminants.
48. Horses may refuse water which has an unfamiliar taste.
49. In horse trailers, air quality becomes worse over time and the effects of opening windows and vents are limited. This can result in respiratory pathology.
50. Pigs are susceptible to motion sickness during journeys and, as in humans, the motion sickness is associated with increased plasma vasopressin concentrations and retching. A period of food deprivation before transport reduces gut loss but probably does not affect motion sickness. Ruminants do not show retching but might still be affected by motion sickness.
51. The fasting of pigs before transport is desirable. However, pigs transported for eight hours or more are strongly motivated to eat and drink. Pigs travelling to slaughter are usually heavy in relation to leg strength and subject to cardiovascular problems.
52. All pigs, cattle, sheep and horses that are unfamiliar with transport vehicles are substantially affected by being loaded on to and unloaded from a vehicle. The adverse effects are generally greatest for pigs. Unloading at a staging point and loading again would have a more adverse effect on all individuals than leaving them on the vehicle provided that the conditions on the vehicle are at least as good as the minimum conditions stipulated in this report.

53. After a journey lasting 12 hours, sheep are highly motivated to eat. However they might not drink until two or three hours later so breaks lasting four hours or less will often cause dehydration and increased welfare problems for sheep. At temperatures of over 20 C, sheep become dehydrated during a 24 h journey.

Chapter 9 **ROLL-ON-ROLL-OFF TRANSPORT**

54. During roll-on roll-off ferry crossings, provided that ventilation is good and the sea is not too rough (wind up to force 4) sheep are less adversely affected than whilst driven along a road in a vehicle. Hence a sea crossing can be considered to be a rest period at such wind speeds. However, motion sickness, noise at a very aversive level, abortion and injury may occur at wind speeds of force 6 or above.
55. On roll-on roll-off ferries, thermoregulation, sufficiency of oxygen, the presence of noxious fumes, high noise levels and sea-induced movements can all be problems for the animals. Most of the worst problems are lessened if there is good air circulation between vehicles, through ventilation slots, and amongst animals on vehicles.

12. RECOMMENDATIONS

12.1. General issues, inspection, disease transmission

1. The welfare of animals unaccustomed to loading and transport is significantly poorer than normal during the first few hours after loading. There is then some degree of adaptation, according to species and conditions, but after a few hours of transport welfare tends to become poorer as journey length increases. Hence such animals should not be transported if this can be avoided and journeys should be as short as possible.

2. An animal transport journey should be regarded as commencing when the first animal is loaded on to a vehicle and as ending when the last animal is unloaded. The same animals should not be regarded as commencing a new journey until a period of 48 hours, in farm conditions sufficient for rest and recuperation of the animals with adequate food and water provided, has passed since the end of the previous journey [See also recommendation 7].

3. All animals should be inspected by the person responsible for them shortly before the commencement of transport in order to ascertain whether they are fit to travel including whether they are clinically free from significant diseases. No animal is fit to travel unless it is able to stand unaided and walk bearing weight on each of its legs. If a disease condition is suspected, or if the journey is expected to last for more than eight hours, a veterinarian should inspect the animals, ideally immediately before departure but in any case no more than 24 hours before the beginning of the journey.

4. Vehicles should be designed so that the basic needs of animals for safety, thermal comfort and adequate movement can be met. The recommendations of the SCAHAW "Report on Standards for the Microclimate inside Animal Transport Road Vehicles" are relevant to this. Vehicles should be designed, animals should be distributed on vehicles, and stocking densities should be adjusted, so that all individuals can be effectively and safely inspected during journeys.

5. All animals on a livestock transport vehicle should be inspected by the person responsible for them to ascertain whether they continue to be fit for transport, no later than eight hours after travel commences. After this time, there should be inspection at the intervals legally required for driver's rest, i.e. once every 4.5 hours. If the individual animals cannot be inspected, travel should be limited to eight hours. Inspection necessitates adequate access to each individual and the possibility to take appropriate remedial action. Adequate inspection is not possible where: there are deck ceilings lower than 1.4 m, animals which can be obscured behind other individuals or animals in crates, so journeys longer than eight hours should not be permitted in these circumstances.

6. In order to reduce the likelihood that animal transport will increase the spread of infectious disease, contact between transported animals, or the products of transported animals, and other farm animals should be minimised. When animals are transported to a farm, a quarantine period is advisable.

7. Since, firstly, unloading animals from vehicles during a rest period and then reloading them again is more stressful than leaving them on the vehicle in good

conditions and, secondly, contact at staging points between animals from different sources can lead to the spread of infectious disease. Pigs, cattle, sheep and horses should not be unloaded from transport vehicles at staging points. This recommendation is linked to the recommendations in this report on the stocking density and other conditions for animals transported for a duration which requires a resting period.

8. The practice of sending animals through markets on their way to slaughter should be discouraged because, firstly, they undergo considerably longer durations of journey from farm to slaughterhouse than those which go direct from farm to a slaughterhouse, and secondly, infectious agents can be spread at markets.

9. If, during a journey, animals are found to be injured or infirm, for example if they are unable to stand up, unable to support their weight on all four limbs or have a broken limb or other serious injury, they should be unloaded in an appropriate place, or humanely slaughtered on the vehicle. They should not be taken to the destination unless this is the nearest appropriate place. If a serious disease condition is suspected, the competent authority for the region should be contacted. In order to humanely slaughter animals on transport vehicles, appropriate equipment must be carried or arrangements should be made for competent persons to carry out the humane slaughter.

10. No person should be allowed to be responsible for assessing that animals are fit for transport, loading animals on to a transport vehicle, driving a road transport vehicle that is carrying livestock, checking that animals on a transport vehicle are fit to continue, or unloading animals from a livestock vehicle unless that person has received proper training and holds a certificate stating this. The training of livestock vehicle drivers should emphasise that when vehicles carrying livestock go around corners or bends, the animals are considerably more vulnerable to the effects of vehicle movement than are human passengers who are seated or able to hold on to a vehicle fitment. Hence slow speeds and careful driving are important. The necessity for careful braking and acceleration should be emphasised.

11. Persons who are responsible for checking, loading, driving on the road, or unloading livestock should not be allowed to be paid according to the speed at which they carry out these tasks and they should not be paid for exceeding the permitted number of animals carried on the vehicle. Payment of bonuses when threshold levels of animal mortality, injury and poor meat quality or other carcass down-grading associated with poor handling and transport are not exceeded is desirable.

12. Insurance of livestock consignments against mortality during journeys or against downgrading of carcasses because of injury or poor meat quality should not be permitted because such insurance might result in poor driving and poor care of animals. This recommendation does not refer to road accident insurance.

12.2. Preparation for transport, handling, loading

13. Animals of different genotype or age, or coming from different environments, may respond very differently to the stress of transport. Therefore, animal welfare recommendations should be tailored whenever possible to each type of animal.

14. Piglets of less than four weeks of age, lambs of less than one week of age and calves of less than two weeks of age should not be transported. Better conditions during transport than for older animals should be provided for piglets of less than 10 kg, lambs of less than 20 kg, calves (up to six months of age) and foals (up to four months of age) [see also Recommendation 34]. For some of these young animals, milk and supplementary heat should be provided.

15. When pigs and male cattle older than 12 months of age are to be transported, individuals which have previously lived in different pens should not be mixed during the six hours before transport, or whilst on the transport vehicle, or whilst in pre-slaughter housing. Vehicles should have moveable pen dividers to adjust pen size appropriately so that groups of animals reared together can be kept together.

16. All farm animals kept in buildings, and in particular pigs and horses, should be given appropriate exposure to humans during their rearing so that the adverse effects of human contact during transport can be minimised.

17. In all pre-transport and post-transport handling of animals, the characteristics of the species, breed and previous experience of individuals should be taken into account so as to minimise any adverse effects of human contact.

18. A twitch should not be used on horses.

19. The grasping or lifting of sheep by their wool should not be permitted.

20. Beating or poking of farm animals with a stick, the use of a stick on sensitive areas such as the eyes, mouth, ano-genital regions or belly, the twisting of tails or ears, and the use of electric goads should not be permitted.

21. Where pigs must be held for a period before loading onto a transport vehicle or after unloading, the space allowance provided should be according to the formulae: $A = 0.03 W^{0.67} \text{ m}^2$ for 3 hours or more, $A = 0.026W^{0.67} \text{ m}^2$ for 30 minutes to 3 hours, and $A = 0.0192 W^{0.67} \text{ m}^2$ for up to 30 minutes, (A = area in m^2 per pig and W is weight of pig in kg).

22. Ramps which animals must ascend or descend for loading or unloading should have non-slippery surfaces and solid sides. It is important that there are few shadows and that lighting inside the vehicle is good. The gradient of ramps should preferably be 8-10° and should never be steeper than an angle of 20° to the horizontal for pigs, calves and horses. Sheep and cattle can climb 20-25° ramps but cleats at 30 cm intervals are needed. Ramps steeper than 20° are not recommended because of the risks if animals panic. Hence a general maximum of 20° is recommended. Loading or unloading systems which eliminate the need for slopes have been developed and their use should be encouraged.

12.3. Space allowance

23. The space allowance provided for each animal which prefers to stand during transport should be such that it can adopt a position maintaining balance without any contact with other animals or with the vehicle or partition walls and without a high risk of falling. The space allowance for each animal which needs to lie during

transport should allow it to adopt a comfortable lying position without a significant risk of being walked on by other animals.

24. All transported horses should be in individual stalls. The top of the partition between the horses should be approximately at the height of the withers and the bottom of the partition should be approximately at the height of the belly. Bars or barriers should separate the heads of adjacent horses. The length and width of the stall should be appropriate for the size of the horse: length 0.6m longer than the distance from nose to back of hindquarters and width 0.4m wider than the width at the widest point on the body.

25. The height of the compartment in which horses are kept should be 0.75 m higher than the height of the horse at the withers. Hence for an average riding horse 1.58 m high, the ceiling height should be at least 2.33 m. As a consequence, horses cannot be transported in multi-deck vehicles.

26. The space allowance for pigs during transport should be according to the formula $A = 0.0192 W^{0.67} \text{ m}^2$ where A is the area in m^2 per pig and W is the weight of the pig in kg. This formula provides 0.42 m^2 for a 100 kg pig, a sufficient space for each pig to lie down throughout the journey. If pigs have to have rest, food and water on the vehicle, the space allowance should be according to the formula $A = 0.0274 W^{0.67} \text{ m}^2$. This formula provides 0.60 m^2 for a 100 kg pig.

27. The space allowance for sheep during transport of 4 hours or less should be according to the formula $A = 0.025 W^{0.67} \text{ m}^2$ for unshorn sheep and $A = 0.021 W^{0.67} \text{ m}^2$ for shorn sheep (fleece length less than 1.5 cm) where A is the area in m^2 per sheep or lamb and W is the weight of the animal in kg. This formula provides 0.29 m^2 for unshorn and 0.24 m^2 for shorn 40 kg sheep.

For journeys of 4-12 hours, during which sheep lie down if driving and other conditions are good, the formula $A = 0.031 W^{0.67} \text{ m}^2$ for unshorn sheep and $A = 0.026 W^{0.67} \text{ m}^2$ for shorn sheep should be used. This formula provides 0.37 m^2 for unshorn and 0.31 m^2 for shorn 40 kg sheep.

For journeys lasting more than 12 hours, during which animals have to rest, feed and drink on the vehicle, the formula $A = 0.044 W^{0.67} \text{ m}^2$ for unshorn sheep and $A = 0.037 W^{0.67} \text{ m}^2$ for shorn sheep should be used. This formula provides 0.53 m^2 for unshorn sheep and 0.44 m^2 for shorn 40 kg sheep.

28. The height of the compartment for pigs and sheep should be 15 cm above the highest point on the animal in vehicles with efficient forced draft ventilation and 30 cm above the highest point on the animal in vehicles with natural ventilation. For young pigs and for sheep, the highest point on the animal is the top of the head when it is held in a comfortable position. For older pigs, the highest point is the middle of the back. The highest point on a 100 kg slaughter pig might be 0.77 m so the compartment could be 0.92 m high in a forced ventilation vehicle but 1.08 m high in a natural ventilation vehicle. Hence, three deck vehicles are allowable if there is forced ventilation but not if there is only natural ventilation. A 250 kg sow might be 97 cm tall and a boar would be taller so sows and boars should never be carried in three deck vehicles.

29. The space allowance for cattle during transport lasting up to 12 hours should be according to the formula $A = 0.021 W^{0.67} \text{ m}^2$ where A is area per animal in m^2 and

W is weight in kg. This formula provides 1.35 m² for a 500 kg animal. For journeys in which a period for rest, feeding and drinking is needed, this rest should be on the vehicle so the formula $A = 0.0315 W^{0.67} \text{ m}^2$ should be used. This formula provides 2.03 m² for a 500 kg animal. Cattle with horns should be given 10% more space.

30. The height of the compartment for cattle should be at least 20 cm above the top of the head of each animal when it is standing in a comfortable position. This figure applies for all vehicles.

31. Animals should not be tied during vehicle movement. If it is necessary to tie animals during loading, the ties must be released prior to vehicle departure. The use of appropriately sized pens on vehicles can obviate the necessity to tie animals.

12.4. Driving quality, vehicle design, journey duration, feeding and watering

32. No animal should be subjected to undue lateral movement of the kind induced by rapid cornering, or to sudden braking or acceleration. Vehicle movements which induce motion sickness should be avoided.

33. The recommendations on journey duration do not distinguish among animals which, after transport, will be slaughtered, kept on farm for a further growth period, or kept on farms for breeding purposes. Given that, with increasing duration of journey, the welfare of animals generally gets worse because they become more fatigued, incur a steadily increasing energy deficit, become more susceptible to existing infections, and may become diseased because they encounter new pathogens, it would be better for slaughter animals to avoid journeys longer than those after which food and water provision is recommended below for each species. However, it is often difficult to distinguish between slaughter animals and other stock with certainty as an animal might be slaughtered after a short holding period, for example on a farm, at the end of initial transport.

34. A maximum of eight hours after a journey commences, horses, pigs, calves (up to 6 months of age) and lambs of 20 kg or less should have a rest period of at least six hours, during which time they have food and water available on the vehicle which all individuals can eat and drink. A maximum of twelve hours after a journey commences cattle and sheep should have a rest period of six hours during which they are provided with, on the vehicle, food and water which all individuals can eat and drink.

For horses, pigs, calves, and lambs (up to 20 kg) when a journey has continued for eight hours, plus six hours rest, plus a further eight hours travel all should have a rest period of at least 24 hours, during which time they have food and water available on the vehicle which all individuals can eat and drink. For cattle and sheep, when a journey has continued for twelve hours, plus six hours rest plus a further twelve hours, all should have a rest period of at least 24 hours, during which time they have food and water available on the vehicle which all individuals can eat and drink. There should be an adequate system for dung removal.

35. Travel by rail is generally preferable to travel by road in relation to animal welfare. The quality of the suspension system of a transport vehicle has a considerable effect on animal welfare. Transport vehicles, especially those used for

long journeys, (longer than 8 hours) must have a suspension system that is at least as good as air suspension on all axles. The walls and roof of the vehicle should be insulated to minimise over-heating or excessively cold conditions. There must be ventilation openings and forced ventilation which can operate independently of the vehicle engine. Forced ventilation must be used when the vehicle is stationary.

36. Trailer design and construction for horses is often inadequate and should be improved. Horse trailers should be stable on the road and should be designed so that horses can raise and lower their heads. Transport vehicles should be suitable for the type of animal being moved and its proper maintenance and operation. Vehicles should be properly designed for provision of food and water to all animals on board if journey duration is such that feeding or watering are required or if the species requires food or water throughout.

37. Hay should be provided for horses on an ad libitum basis throughout the journey and water should be offered after 8 hours at up to 25C and 6 hours above 25C. During air transport water must be offered every 2-4 hours during transit if environmental temperatures are above 25C.

38. Pigs should be fasted before collection and transport. This fasting must not exceed 10 hours.

39. At temperatures of 20 C and above pigs must be offered water at every driver's break during a journey. Water should be made available only during stops and should be turned off when the vehicle is in motion.

40. Pigs should be given a light meal at the beginning of a journey break of 6 hours or longer.

41. The transport of lactating sows, whose piglets have been removed within the last 48 hours, should be avoided where possible but, if they are transported, the journey should not last for more than 4 hours.

42. For cattle, water must be provided by self-operated drinkers on the lorries for all journeys longer than 4 hours. The animals must be familiarised with the type of drinkers.

12.5. Roll-on roll-off ferries.

43. Forced ventilation systems should be available on vehicles carried below decks on roll-on roll-off ferries.

44. Since pregnant animals need extra space and are more adversely affected by confined conditions and poor ventilation, the stocking density on the vehicles on roll-on roll-off ferries should be 20% lower for animals in the last third of pregnancy.

45. Sea crossings of animal transport vehicles on roll-on roll-off ferries should not be permitted if there is a likelihood of winds of force 5 or above, or if sea conditions are those produced by such winds.

13. EXECUTIVE SUMMARY

The welfare of animals, including their health can be substantially affected in the course of and as a result of transport. There is now much scientific information about welfare in relation to transport and many studies have been conducted since the E.U. Scientific Veterinary Committee Report in 1992. This is the first part of a report on the welfare of animals during transport and concerns general issues (Chapters 1-5) and specific information on horses, pigs, sheep and cattle (Chapters 6-10). A second part of the report will follow.

Since loading and transport are stressful to animals unaccustomed to them, for these animals transport should be avoided wherever possible and journeys should be as short as possible. When animals are to be transported, they should be: prepared for the experiences associated with the journey, loaded carefully, kept at a stocking density and with a roof height which meet their needs for normal movements and resting positions, driven in such a way that they can maintain their balance at all times, fed, watered and rested according to their needs, and unloaded carefully. The person responsible for the animals should be properly trained, should have a route plan with information about whom to contact in emergency in all points of the journey, and should inspect the animals before the journey and at intervals adequate to detect problems. Details of these requirements are given in this report and may differ according to species.

Poor welfare in transported animals is caused by the stressful conditions which they encounter during loading and transport and also by disease which is exacerbated during transport or transmitted during and as a result of transport. Classical swine fever and foot and mouth disease are recent examples of diseases transmitted when animals were transported. Such diseases are important animal welfare problems, as well as economic problems. Hence: contact between transported animals and other farm animals should be minimised, quarantine periods on farms are advisable after transport, the use of markets for slaughter animals should be discouraged, and animals should not be unloaded from vehicles at staging points. As a consequence of this last recommendation, on longer journeys where a rest period is needed, animals should have space for resting, feeding and watering.

Some of the poorest welfare in transported animals is caused by bad treatment of animals during loading or unloading, by bad driving, or by lack of proper inspection. In order to minimise such problems: persons responsible for animals should be trained and hold a certificate stating this, such persons should be paid in a way that encourages good practice, and it should not be possible to insure against the results of practices which result in poor welfare.

Since pigs and adult male cattle may fight if mixed, resulting in poor welfare and carcass damage, such animals should not be mixed with individuals that have previously lived in different pens. Vehicles should have moveable pen dividers. Because of the dangers of group transport for horses, they should be transported in individual stalls. Animals should not be tied when in moving vehicles.

Many animals are forced to move up or down ramps which are too steep during loading and unloading. Systems which eliminate the need for ramps or purpose-

built ramps no steeper than 10° are desirable. No animal should be required to negotiate a ramp steeper than 20°.

Equations for calculating the floor area to be provided on vehicles are presented in the report. The recommended space allowances for sheep during journeys of up to 4 hours and for cattle on journeys of up to 12 hours are sufficient for the animals to stand maintaining balance without any contact with other animals or the vehicle walls. The recommended space allowances for pigs on journeys of up to 8 hours and for sheep of 4-12 hours take account of the need for these animals to lie down in a comfortable lying position without risk of being walked on by other animals. The recommended space allowances for journeys of more than 8 hours for pigs and more than 12 hours for sheep and cattle are sufficient for the animals to rest in a comfortable position and for all to move around to feed and drink. The ceiling heights recommended allow comfortable standing and adequate ventilation. As a consequence, horses of average size cannot be transported in multi-deck vehicles and adult sows and boars cannot be transported in three deck vehicles.

It is important that there should be careful driving of animal transport vehicles so that there is less lateral acceleration during cornering and less sudden braking than is normally accepted by human passengers.

Since inspection of animals requires that every individual can be properly checked and this is not possible in some cases, for example where animals are in crates or where deck ceilings are 1.4 m or lower, in these cases the journey duration should not be longer than the eight hours after which inspection should be carried out. Food and water should be provided 8 hours after a journey commences for horses, pigs, calves and lambs and twelve hours after a journey commences for older sheep and cattle. The period of provision of food and water also allows rest and should last for 6 hours. After this a further 8 or 12 hour journey can occur before a 24 hour rest is needed. Pigs should be offered water at every driver's break when the temperature is 20C or above and ad libitum hay should be provided for horses during transport.

Where vehicles are carried on roll-on roll-off ferries, forced ventilation systems are required if the vehicles will be below decks. Sea crossings should not be permitted if winds of force 5 or above are likely or if sea conditions are those produced by such winds.

Recommended minimum floor space allowances – examples

Species	Category	Bodyweight (Kg)	Travel duration (hour)	Floor space allowance (m²)
Pig		100	Up to 8	0.42
			More than 8	0.60
Sheep	Shorn	40	Up to 4	0.24
			4-12	0.31
			More than 12	0.38
	Unshorn	40	Up to 4	0.29
			4-12	0.37
			More than 12	0.44
Cattle		500	Up to 12	1.35
			More than 12	2.03

Recommended maximum journey segments (hour)

SPECIES	1st Travel period	1st Rest	2nd Travel period	2nd Rest
Horses, pigs, calves, lambs	8	6	8	24
Sheep, cattle	12	6	12	24

Continue 3rd and 4th travel periods etc. as 1st and 2nd.

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