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Report 764

Note on minimum space allowance and compartment height for cattle and pigs during transport

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Abstract
Graphical presentation of guidelines for minimum space allowances for cattle and pigs during transport

Keywords
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Ministry of Economic Affairs

Table of contents

1 Introduction

The welfare of animals during transport is for a significant part dependent on the ability of the animals to perform natural behavioural patterns such is standing and lying, to adopt a natural position, to minimize risks for injuries, stress, panic and to ability to thermoregulate effectively.

The Regulation EC 1/2005 sets minimum requirements for space allowances and compartment height for cattle and pigs. The Scientific Opinion (EFSA 2011) has thoroughly reviewed the scientific basis for the minimum requirements.

The Dutch Ministry of Economic Affairs has requested to have this scientific basis translated into graphical presentations and tables to be used in practice. Additionally, a short summing-up of other aspects related to the need of a minimum space allowance and deck height need to be provided.

2 Space allowances

Absolute minimum space allowances are determined by the physical dimensions of animals (Petherick 1983). Yet, *acceptable* minimum allowances are dependent on various other factors. These include:

- Ambient conditions (environmental temperature, adequate ventilation, relative humidity)
- Ability of the animals to thermoregulate effectively (i.e. huddling behaviour at night)
- Need for animals to lie down, to be watered or to be fed

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.

Whether animals *need* to lie down and rest is dependent on the animal's age, health and physical condition, and journey length.
Whether animals will lie down is dependent on the transport conditions and journey length, if it is comfortable to do so, namely stocking density, driving quality, road conditions, and suspension characteristics of the transport vehicle. At some point it may be necessary for the animals to rest and to avoid states of fatigue or exhaustion.

2.1 Bovines

For bovines the Regulation EC 1/2005 provides regarding minimum space allowances for transport by road (table 1.)

Table 1. Minimum space allowance for cattle transported by road set by the Regulation EC 1/2005

Category	Approximate weight (in kg)	Area in m^2/animal
Small calves	50	0.30 – 0.40
Medium sized calves	110	0.40 – 0.70
Heavy calves	200	0.70 – 0.95
Medium sized cattle	325	0.95 – 1.30
Heavy cattle	550	1.30 – 1.60
Very heavy cattle	>700	>1.60

Various studies have focussed on the allometric equation specifying minimum space allowance for cattle during transport using the equation: Area (m^2) = k x (Live Weight in kg)^a ; with k being a constant and a the power. Table 2 provides a comparison of the outcomes of different studies for the animal categories specified in the Regulation EC 1/2005.

Table 2. Comparison of outcomes various studies on minimum space allowances for cattle during transport

Approximate weight (in kg)	Petherick 1983[1]	Randall 1993[2]	FAWC 1991[3]	SCAHAW 2002[4]	Petherick 2007[5]	Petherick and Phillips 2009[6]	Regulation EC 1/2005
50	0.25	0.21	0.29	0.21 – 0.43	0.25 – 0.37	0.26 – 0.37	0.30 – 0.40
110	0.42	0.39-9	0.49	0.39 – 0.72	0.42 – 0.63	0.44 – 0.62	0.40 – 0.70
200	0.63	0.62	0.73	0.62 – 1.08	0.63 – 0.94	0.65 – 0.92	0.70 – 0.95
325	0.86	0.91	1.01	0.91 – 1.49	0.86 – 1.30	0.90 – 1.28	0.95 – 1.30
550	1.22	1.37	1.44	1.37 – 2.11	1.22 – 1.85	1.28 – 1.81	1.30 – 1.60
700	1.43	1.66	1.69	1.66 – 2.48	1.43 – 2.18	1.50 – 2.13	>1.60

[1] Petherick (1983) used the equation 0.019 x (live weight)$^{0.66}$
[2] Randall (1993) used the equation 0.01 x (live weight)$^{0.78}$
[3] FAWC (1991) used the equation 0.021 x (live weight)$^{0.67}$
[4] SCAHAW (2002) used the equation 0.01 x (live weight)$^{0.78}$ for standing cattle and 0.0315 x (live weight)$^{2/3}$ for cattle allowed to feed, drink and rest
[5] Petherick (2007) used the equation 0.019 x (live weight)$^{0.66}$ for standing cattle and 0.027 x (live weight)$^{0.67}$ for lying cattle
[6] Petherick and Phillips (2009) used the equation 0.019 x (live weight)$^{2/3}$ for standing cattle and 0.027 x (live weight)$^{2/3}$ for lying cattle

As later studies put forward, more space is necessary when animals need to rest, are provided with water and/or food. This extra space may increase with 50% (SCAHAW, 2002).

Several scientists have stressed that more space is needed to lie down when animals are transported after any 8-12 hour period of vehicle movement (SCAHAW, 2002; EFSA, 2011; EFSA presentation Dr. Oriol Ribó, 2010). Similarly, Randall (1993) recommended that equations used for standing cattle (i.e. equation of FAWC (1991)) are only suitable for short journeys, which was defined as less than 5 hours.

Moreover, a limited number of studies have focussed on the extra need of space for any animal to change position from standing to lying or vice versa: the area required to move between lying and standing, and vice versa, can be described by the equation area (m^2) = 0.047 x (live weight) $^{0.66}$ (Petherick, 2007). When this extra area is taken into account, the values for the above mentioned categories of cattle will increase significantly (table 3).

Table 3. Minimum space allowance for cattle to move between lying and standing and vice versa

Category	Approximate weight (in kg)	Area in m^2/animal for the movement between lying and standing and vice versa
Small calves	50	0.62
Medium sized calves	110	1.05
Heavy calves	200	1.55
Medium sized cattle	325	2.14
Heavy cattle	550	3.03
Very heavy cattle	700	3.55

Cattle with horns require 7% more space than their polled or dehorned counterparts.

In 2011, the EFSA has published a scientific opinion on the welfare of animals during transport. In this opinion they thoroughly review the scientific knowledge on space allowances and they stress that space allowances should be regarded as guidelines since physical condition of animals, different animal categories, meteorological conditions and likely journey times may require more different figures.
Furthermore, they state that, the lower and upper limits of the range of space allowances specified by Regulation EC 1/2005 are similar to the values derived by Petherick and Philips (2009) for standing and lying cattle respectively. Additionally the EFSA (2011) recommends to use the above mentioned values (based on the equation of Petherick and Phillips (2009)) to allow for journeys up to 12 hours and journeys over 12 hours respectively. Additionally, they recommend space allowances to be calculated according to the equation 0.0315 x (live weight)$^{2/3}$ if cattle are to be offered feed and drink on a vehicle as well as space to rest.

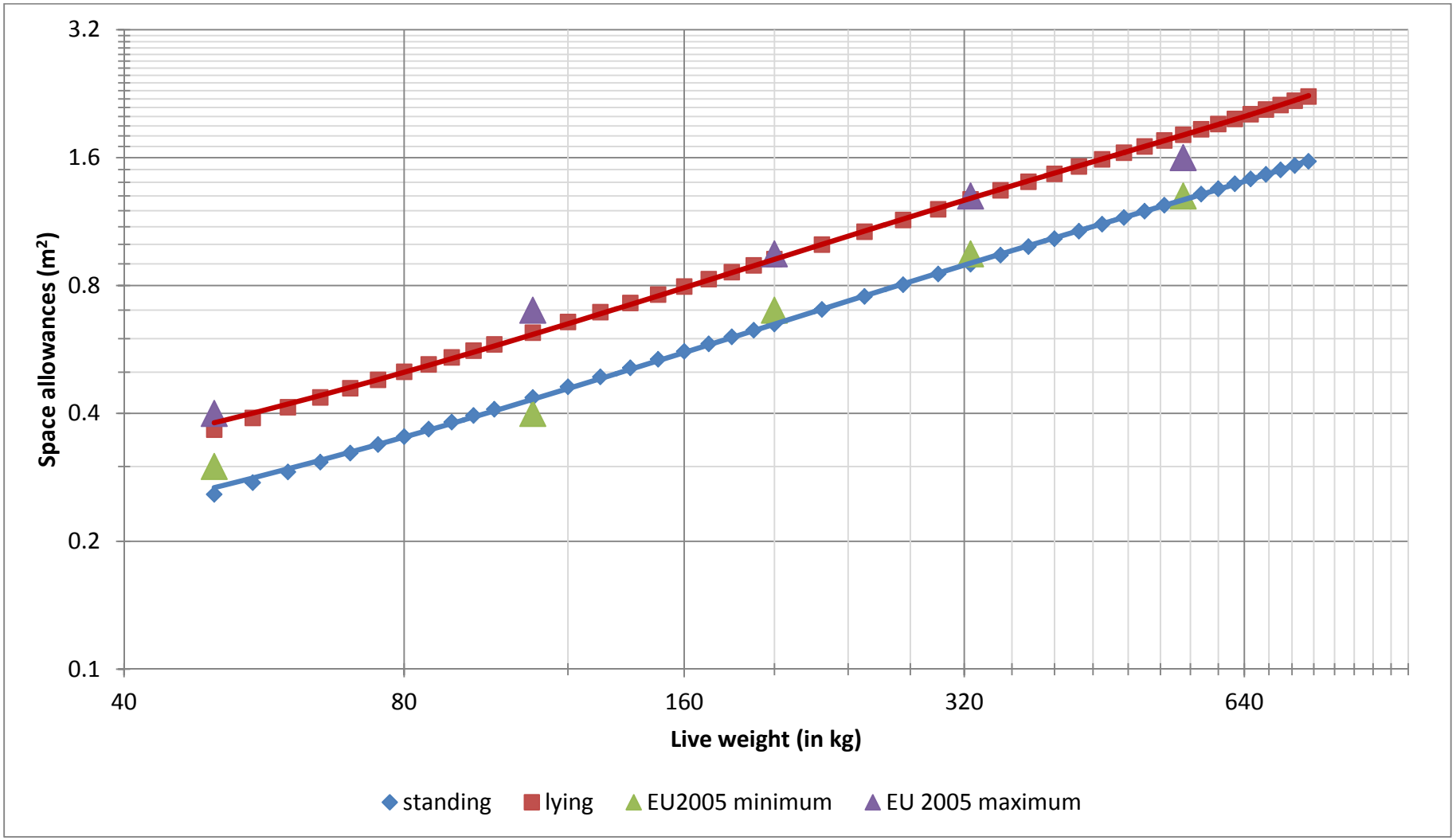
Following this reasoning, the following table (table 4) and figure (figure 1), with recommended space allowances for cattle of various live weights, can be used as a guideline.

Table 4. Minimum space allowances for cattle standing or lying during transport[7]

	Space allowance (m2) for cattle transport	
Live weight (kg)	Minimum for standing	Minimum for lying
50	0.26	0.37
55	0.27	0.39
60	0.29	0.41
65	0.31	0.44
70	0.32	0.46
75	0.34	0.48
80	0.35	0.50
85	0.37	0.52
90	0.38	0.54
95	0.40	0.56
100	0.41	0.58
110	0.44	0.62
120	0.46	0.66
130	0.49	0.69
140	0.51	0.73
150	0.54	0.76
160	0.56	0.80
170	0.58	0.83
180	0.61	0.86
190	0.63	0.89
200	0.65	0.92
225	0.70	1.00
250	0.75	1.07
275	0.80	1.14
300	0.85	1.21
325	0.90	1.28
350	0.94	1.34
375	0.99	1.40
400	1.03	1.47
425	1.07	1.53
450	1.12	1.59
475	1.16	1.64
500	1.20	1.70
525	1.24	1.76
550	1.28	1.81
575	1.31	1.87
600	1.35	1.92
625	1.39	1.97
650	1.43	2.03
675	1.46	2.08
700	1.50	2.13
725	1.53	2.18
750	1.57	2.23

[7] Based on the equation: space allowance = 0.019 x (live weight)$^{2/3}$ for standing cattle and space allowance = 0.027 x (live weight)$^{2/3}$ for lying cattle. Source: EFSA Journal 2011: 9(1):1966 and Petherick and Phillips (2009): Applied Animal Behaviour Science 117 (2009) 1–12

Figure 1. Minimum space allowances for cattle standing or lying during transport[8]



[8] Based on the equation: space allowance = 0.019 x (live weight)$^{2/3}$ for standing cattle and space allowance = 0.027 x (live weight)$^{2/3}$ for lying cattle. Source: EFSA Journal 2011: 9(1):1966 and Petherick and Phillips (2009): Applied Animal Behaviour Science 117 (2009) 1–12

2.2 Pigs

Following the Regulation EC 1/2005 “all pigs must at least be able to lie down and stand up in their natural position”. “In order to comply with these requirements, the loading density for pigs of around 100 kg should not exceed 235 kg/m^2”.

The above specified space allowance results in 0.42m^2 per pig weighing 100 kg. With this amount of space pigs will lie down on the sternum and some animals lying so that they overlap the bodies of others (SCAHAW, 2002).

Under thermoneutral conditions, pigs of weights between 25 and 100 kg lie down a great part of the day (Ekkel et al., 2003). As a starting point for floor space requirements should be based on the estimated floor area for half recumbent pigs, with an equation 0.033 x (live weight)$^{0.66}$ (Petherick, 1983)

There is very limited studies regarding the allometric equation most appropriate to describe the minimum space allowance for pigs during transport. The minimum space allowance as specified by the Regulation EC 1/2005 is in accordance with the equation 0.0192 x (live weight)$^{0.67}$; and is found to be appropriate for transport during which no food and water provision occurs (SCAHAW, 2002). However, when animals need room for resting, feeding and obtaining water the equation 0.0274 x (live weight) $^{0.67}$ is more appropriate. This provides 0.60 m^2 per 100 kg pig. In a study by Gerritzen et al. (2013) it was shown that with a loading density of 179 kg/m^2 pigs displayed more resting behaviour compared with the loading density of 235 kg/m^2. This provides 0.56 m^2 per 100 kg pig, and approximates the values for pigs that need room for resting and drinking (SCAHAW, 2002).

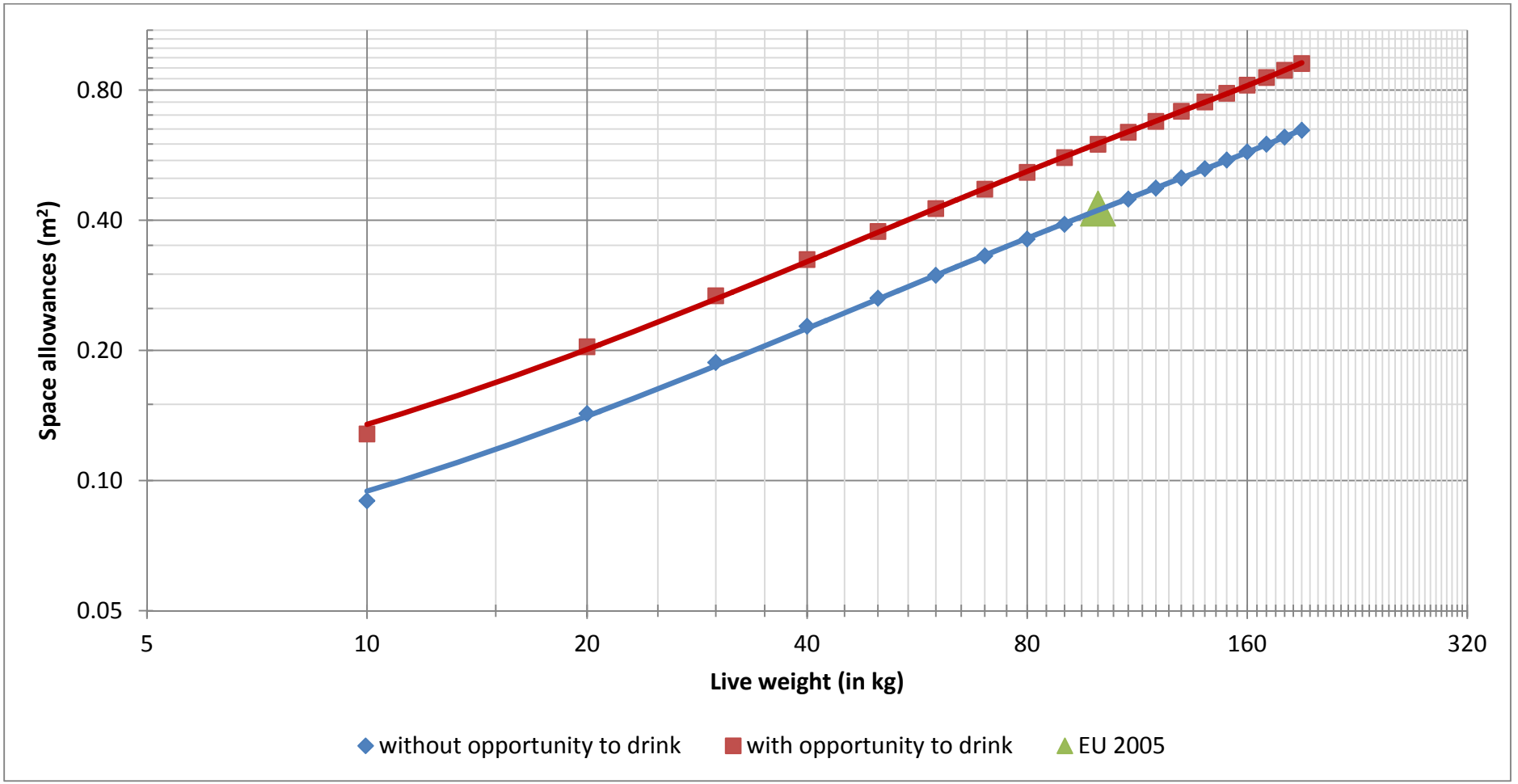
Based on the above mentioned findings, the following table (table 5) and figure (figure 2), with recommended space allowances for pigs of various live weights, can be used as a guideline.

Table 5. Minimum space allowances for pigs lying during transport[9]

	Space allowance (m^2) for pig transport	
Live weight (kg)	Without opportunity to drink	With opportunity to drink
10	0.09	0.13
20	0.14	0.20
30	0.19	0.27
40	0.23	0.32
50	0.26	0.38
60	0.30	0.43
70	0.33	0.47
80	0.36	0.52
90	0.39	0.56
100	0.42	0.60
110	0.45	0.64
120	0.47	0.68
130	0.50	0.71
140	0.53	0.75
150	0.55	0.79
160	0.58	0.82
170	0.60	0.86
180	0.62	0.89
190	0.65	0.92

[9] Based on the equation: space allowance = 0.0192 x (live weight)$^{0.67}$ for pigs travelling without opportunity to drink and space allowance = 0.0274 x (live weight)$^{0.67}$ for pigs with opportunity to drink. Source: Scientific Opinion Animal Health Animal Welfare, 2002

Figure 2. Minimum space allowances for pigs lying during transport[10]



[10] Based on the equation: space allowance = 0.0192 x (live weight)$^{0.67}$ for pigs travelling without opportunity to drink and space allowance = 0.0274 x (live weight)$^{0.67}$ for pigs with opportunity to drink. Source: Scientific Opinion Animal Health Animal Welfare, 2002

3 Compartment height

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 (SCAHAW, 2002).

For animals, which may stand during the journey, the deck height must be well above the heads of the tallest animals when standing with their heads up in a natural position (SCAHAW, 2002; TRAW, 2009). However, this natural position is not further specified.

In the Regulation EC 1/2005 it is stated that “sufficient floor area and height is provided for the animals, appropriate to their size and the intended journey”. For animal species such as Equidae this is further quantified: “the minimum internal height of compartment shall be at least 75 cm higher than the height of the withers of the highest animal”. There are no further specifications given for cattle and pigs.

3.1 Bovines

With insufficient space above the head, the animal cannot maintain a natural positions when standing, will have a higher risk of injuries (especially at the back and root of the tail). Furthermore, effective ventilation, especially when the vehicle is stationary and no artificial ventilation is used, is at risk. In the Scientific Opinions it is stated that the minimum space between head of the animals (standing in natural position) and ceiling is 20cm because of ventilation (SCAHAW, 2002) or because of unhindered movements, and risk of injuries (EFSA, 2011).

A limited number of studies have focussed on the effect of different deck height on behaviour, injuries, and ventilation.

In the study of Lambooij et al., (2012) it was found that both adult cattle as well as veal calves all head butted the roof with 10, 15 and 20cm clearance above the withers of the tallest animal. But head-butting, exploration and pushing did not differ significantly between the animal groups and compartment heights. Furthermore, no additional superficial skin damage was observed after transport. Nevertheless, Lambooij et al., (2012) concluded that in order to enable cattle to express their normal behaviour and not head but the roof sufficient space has to be provided, it is therefore suggested to have a clearance of more than 20 cm above the withers during transport.

Steinkamp and Marahrens (2012) studied the ventilation capacity and risk of injuries for cattle on long distance transport with ceiling heights of 10 and 20 cm above the withers of the tallest animal in combination with different stocking densities. They found no injuries, swellings or hairless patches on the back or the head of the heifers transported over 1000 km. Continuous recorded behaviour revealed that heifers did touch the ceiling, but this was interpreted as exploring, not as butting. They concluded that there were no signs of evidence of injuries or lesions with compartment height of 10cm above the withers of the tallest animal. Furthermore, this study showed that in cold to moderate climate conditions (winter), during driving, ceiling heights of 10 and 20 cm above the withers, did not negatively affect the temperature in the truck. However, it is recommended that when the truck is not moving, artificial ventilation is necessary to prevent heat stress for the animals.

The above mentioned studies have generated different findings, which can be attributed partly to different methods used for the set-up of the study. The EFSA (2011) recommendations are merely based on the study of Lambooij et al. (2012) which unfortunately did not include the ventilation aspect. At this point, there is very little scientific evidence for the recommended minimum compartment height of 20cm above the withers of the tallest animal of the EFSA (2011); the results of the study of Steinkamp and Marahrens (2012) with lower compartment height and the effect on ventilation should be taken into account.

3.2 Pigs

Pigs are usually transported in large trucks that may hold over 200 animals in 3 moveable tiers with a compartment height of round about 90 cm.

With pigs it is less feasible as with cattle to measure the height at the withers of the tallest animal. Barton Gade and Vorup (personal communication, SCAHAW 2002.) showed that the relationship between live weight and average height of an animal is curvilinear and could be described by the equation: Height(cm) = 38.8639 + 0.4272 Weight(kg) - 0.0008375 Weight(kg)^2. Using this equation table 6 presents the expected height of pigs with different weights.

Table 6. Expected height (in cm) of pigs with different live weight.

Live weight (kg)	Expected height (cm)
10	43
20	47
30	51
40	55
50	58
60	61
70	65
80	68
90	71
100	73
110	76
120	78
130	80
140	82
150	84
160	86
170	87
180	89
190	90

Due to lack of scientific studies, it is not possible to do a general recommendation regarding the minimum compartment height for pigs during transport. More importantly, from animal welfare point of view the areal aspect of room is much more important compared to the height, under the condition that freedom of injuries and heat stress is guaranteed (personal communication, Marahrens, 2014).

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